February

THE TECHNICAL WORLD MAGAZINE

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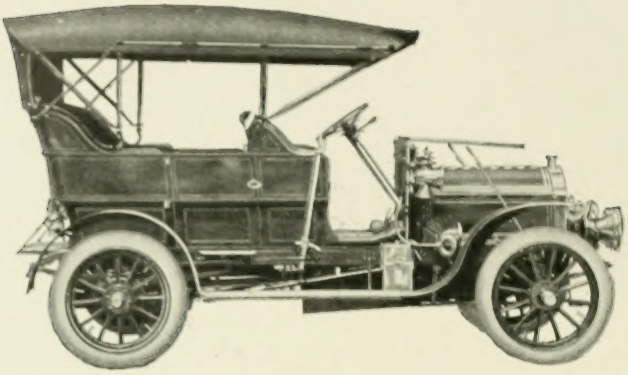

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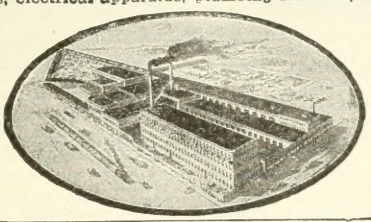

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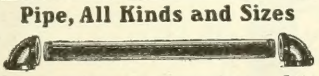

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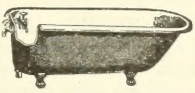

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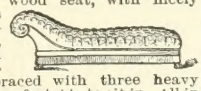

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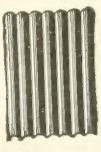

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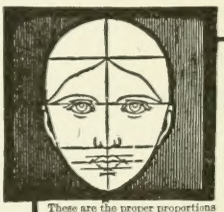

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CONTENTS.

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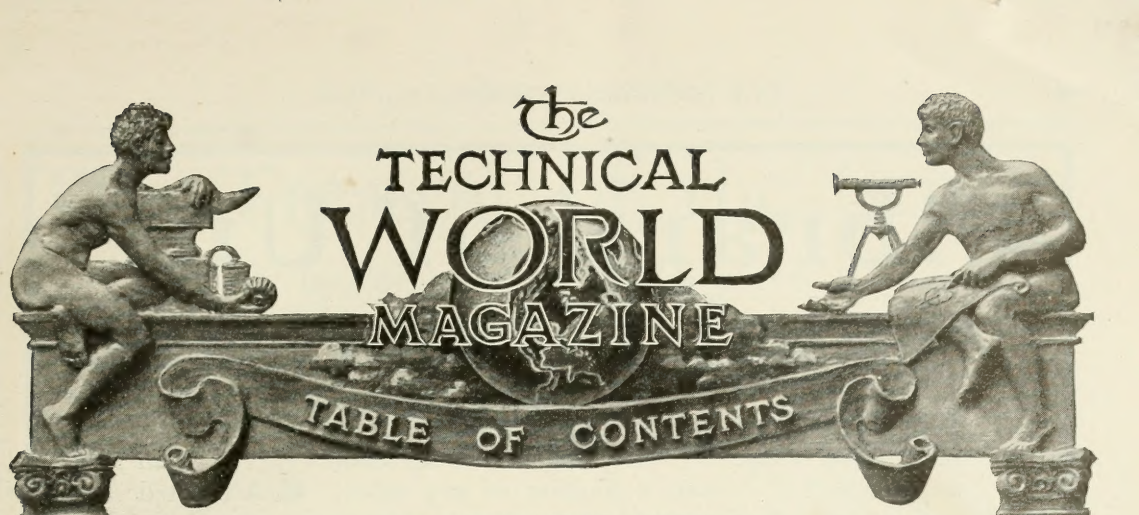

FEBRUARY, 1906

	Page
Cover Design by Howard Heath.	
Work. A Poem. By Henry Van Dyke. Back of frontispiece.	
Frontispiece. A Bessemer Converter in Full Blast.	
Story of the Steel Industry. By G. P. Blackiston	661
In the Water-Forest of the Spree. By Fritz Morris	674
Where History Was Made	678
Great Chance for Tea Farmers. By Freeman Tilden	680
Put to Sleep by Blue Light. By Frank C. Perkins	686
Romance of the Wild-Beast Trade. By William G. Fitz-Gerald	688
Bridge Building in the Jungle. By George R. Metcalfe, M. E.	696
Wonder Cities of Electricity. By S. Morgan Bushnell	698
Dancing Carnival at Binche. By William G. Fraser	707
Voting Machines in Use. By Isaac N. Powell	710
Brilliants. By Richard Watson Gilder	715
Diving for Salt in the Dead Sea. By William George	716
Vast Water Power is Wasted. By Alton D. Adams	717
Dictating Letters by Telegraph. By Wilbert Melville	723
Concrete Wall Defies Niagara. By Orrin E. Dunlap	725
Poison—Man's Best Friend. By Hollis W. Field	729
In a "Flying" Laboratory. By B. R. Winslow	733
"Which Branch of Engineering Shall I Take Up?" No. III. Bridge Engineering. Interview with Ralph Modjeski. By John L. Ray	737
Floating Dry-Dock "Dewey." By Waldon Fawcett	740
The Wireless Death. By C. S. Raymond	742
Folded Hands. Poem. By Ola Moore	750
Furnace System of Warming. By Charles L. Hubbard, M. E.	751
Make Alcohol from Sawdust. By John C. Jenkins	754
Consulting Department	756
Setting Lathe Tools. By Frederick W. Turner	760
Course in Sloyd for Boys. Third Lesson. By Harris C. Trow, S. B.	763
Blowing Off Steam	766
Chalk Talks. No. XXIV. The Helix. By Carl S. Dow, S. B.	768

THE TECHNICAL WORLD MAGAZINE is a monthly magazine, published the fifteenth of each month, preceding date, devoted to the problems of the technical and industrial world, and a treatment of all matters of interest in Applied Science.

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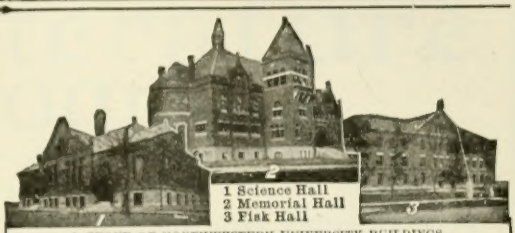

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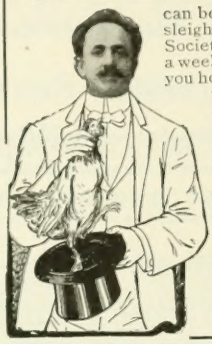

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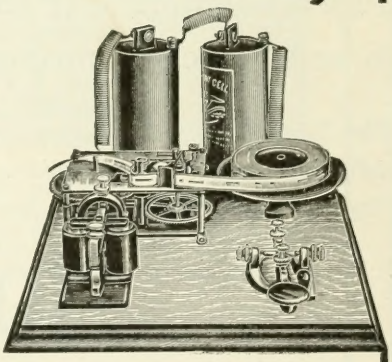

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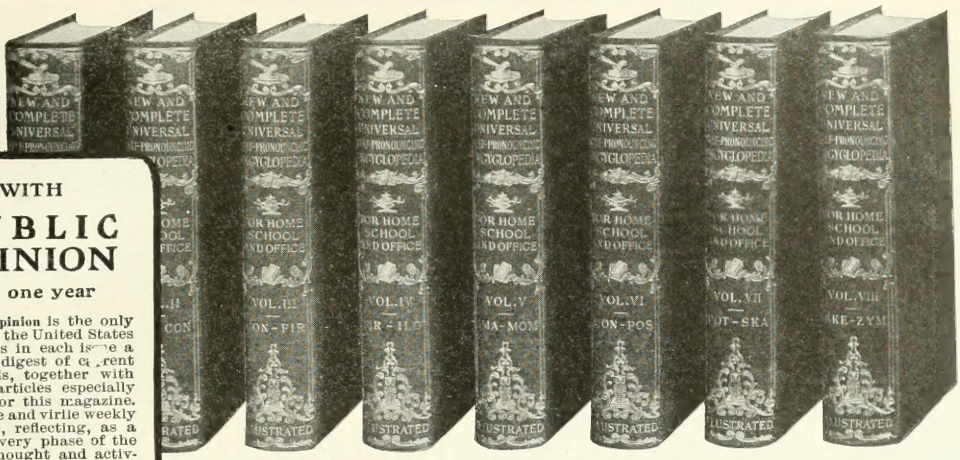

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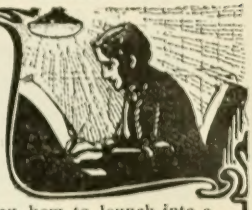

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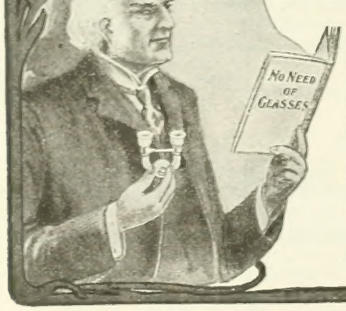

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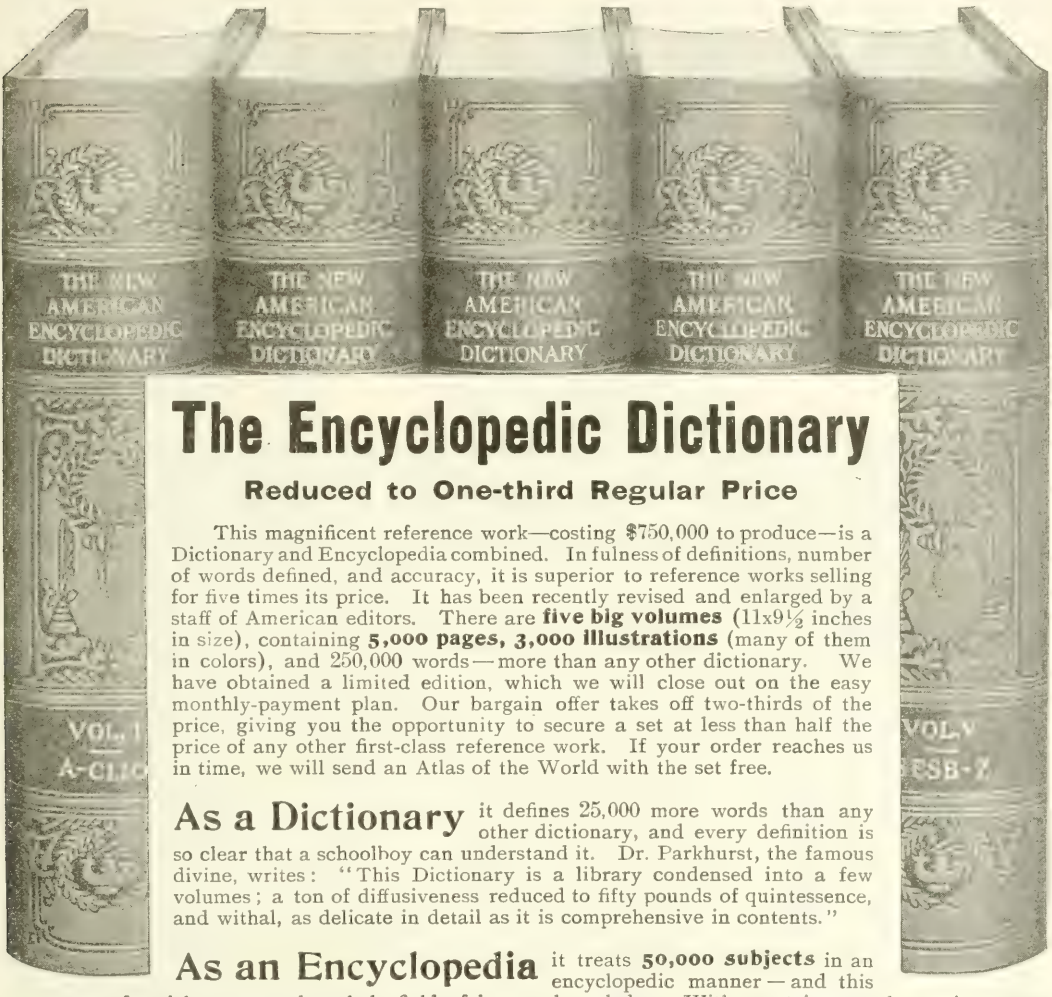

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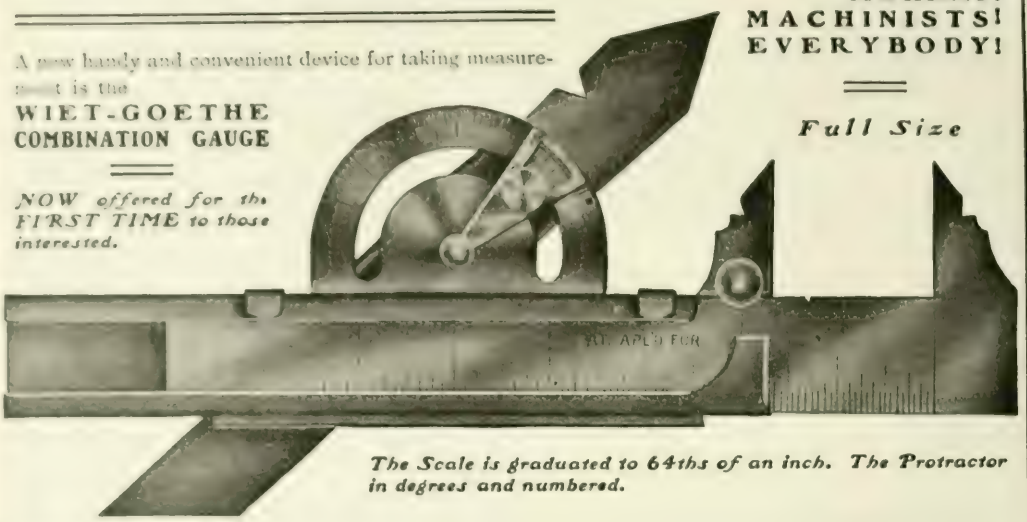

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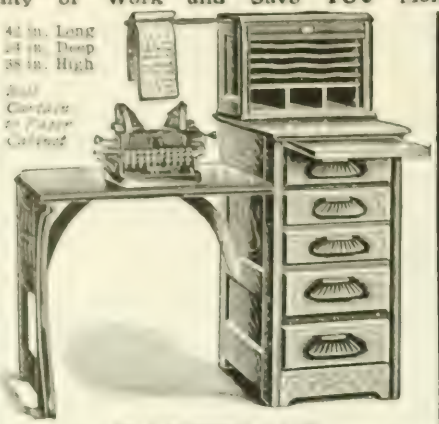

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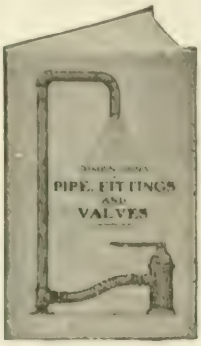

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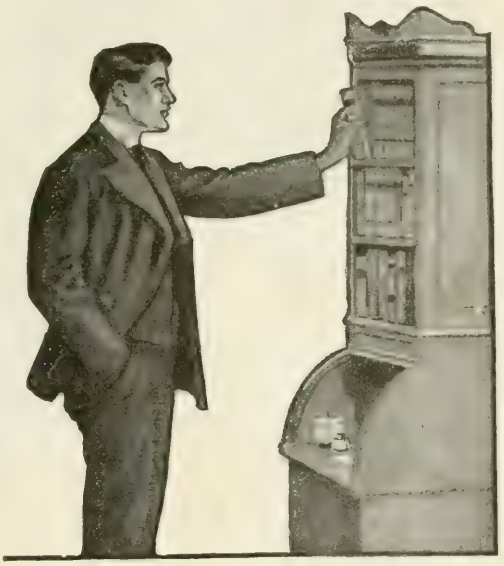

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T. W. 2-06.

Chicago, Illinois

COLLIER'S EXPOSÉ

OF THE

PATENT MEDICINE FRAUD

Death's Laboratory

(A CAUTION)

"Patent medicines are poisoning people throughout America [illegible] are led headlong under the [illegible] syrup. Women are led to [illegible] by reading in the papers about [illegible] Young men and boys [illegible] by various stimulants who [illegible] through seductive advertisements."

June 3d

Criminal Alliance of the Newspapers with Fraud and Poison

"Newspapers have come to rely too much upon the success of [illegible] It is high time for Journalism to bark ferociously against the reign of graft in politics or in high finance, but it can practice a little *real* reform, if it chooses, by canceling some of the most profitable results of its own limberness of conscience."

July 8th

The Great American Fraud

"Gullible America will spend this year some seventy-five [illegible] for patent medicines. It will swallow huge quantities of alcohol, an appalling amount of opiates and narcotics, a wide assortment of varied drugs, ranging from powerful and dangerous heart depressants to insidious liver stimulants, and, for its excess of all other ingredients, undiluted fraud."

October 7th

Peruna and the Bracers

"So well recognized is the use of Peruna for its alcoholic effects that a number of Southern papers advertise a cure for the 'Peruna habit.' What makes Peruna profitable to the maker and a curse to the community at large, is the fact that the minimum dose first ceases to satisfy; then the moderate dose, and finally the maximum dose; and the unsuspecting patron, who began [illegible] goes on to use it as a beverage, and [illegible] by it as a habit."

October 28th

Conspiracy Against the Freedom of the Press

"Such was no mean intellect which devised the scheme whereby every newspaper in America is made an active lobbyist for the Patent Medicine Association. The man who did it is the present president of the organization; its executive head in the work of suppressing public knowledge, stifling public opinion, and warding off public legislation."

Nov. 4th

Liquozone

"Liquozone is sulphurous and sulphuric acids (corrosive poisons) heavily diluted; that is all. Will the compound destroy germs in the body? A series of tests conducted by the Lederle Laboratories answers the question in this summary: 'To summarize, we would say that *Liquozone had no curative effect*, but did, when given in pure form, lower the resistance of the animals so that they *died a little earlier than those not treated.*'"

Nov. 18th

The Subtle Poisons

"Nostrums there are, which reach the thinking classes as well as the readily gulled. Depending as they do for their success upon the lure of some subtle drug concealed under a trade-mark name, or some opiate not readily obtainable under its own label, these are the most dangerous of all quack medicines, not only in their immediate effect, but because they create enslaving appetites, sometimes obscure and difficult of treatment; most often, tragically obvious. Of these concealed drugs, the headache powders are the most widely used."

Dec. 2d

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Work

LET me but do my work from day to day
In field or forest, at the desk or loom,
In roaring market-place or tranquil room;
Let me but find it in my heart to say,
When vagrant wishes beckon me astray,
"This is my work—my blessing, not my doom;
Of all who live, I am the only one by whom
This work can best be done, in the right way."

Then shall I see it not too great nor small
To suit my spirit and to prove my powers;
Then shall I cheerful greet the laboring hours,
And cheerful turn, when the long shadows fall
At eventide, to play and love and rest,
Because I know for me my work is best.

—*HENRY VAN DYKE.*

A BESSEMER CONVERTER IN FULL BLAST, TURNING IRON INTO STEEL.

The Technical
World Magazine

Volume IV FEBRUARY, 1906 No. 6

Story of the Steel Industry

Titanic Business which Sets the Pace for Modern Civilization

By G. P. BLACKISTON

Iron and Steel Expert

THE giants of to-day are sons of Tubal Cain. This is the age of steel. From the delicate embroidery needle in the white hand of a woman, to the one hundred-ton gun, belching forth death to distant battleships, the most important tools of civilization are made of steel.

Far-leaping steel bridges, towering steel sky-scrapers, deep steel tunnels under the earth, steel greyhounds of the ocean, steel engines running more and more swiftly across continents on steel tracks—the potent alloy of iron makes them all possible.

The steel industry has made an almost unbelievable number of millionaires; it is the index to the prosperity of the whole people; it marks also the place of a nation among its peers.

The United States makes more than one-third of the world's production of steel—fifteen millions out of a total of thirty-six and one-half millions of tons; it is the richest and most prosperous among the nations. The two statements are complementary. Germany comes second, with an annual production of 8,000,000 tons; and England third, with 5,000,000 tons.

The 450 steel works scattered throughout the United States represent a total investment of over $442,000,000, and pay $103,000,000 annually in wages. These figures cover only the actual production of steel in its crude form, a process in which man has rapidly been superseded by the marvelous and all but human machines. The magnitude of the industry in its entirety, representing a capital of billions and employing millions of wage-earners, may therefore be imagined.

Definition of Steel

Steel is so closely allied, in certain particulars, to cast and wrought iron, that a complete and satisfactory definition of it is almost impossible. Though differing considerably in their physical and chemical properties, they are all alloys of iron and carbon, the essential difference among them being in the percentage of carbon.

Wrought iron usually contains less than 0.30 per cent of carbon, and is not materially susceptible to hardening when suddenly cooled. It invariably contains slag and is malleable. It is the product of the "puddling" furnace.

Steel usually contains between 0.08 and

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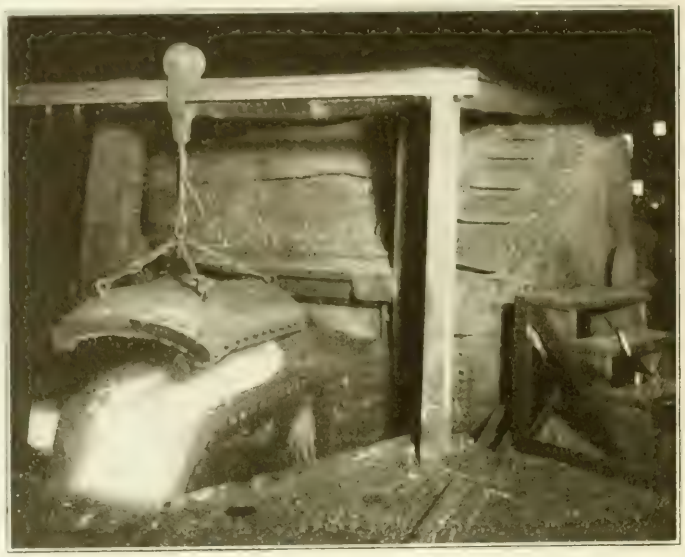
2.40 per cent of carbon. Although its minimum limit extends within the bounds of wrought iron, it is free from slag. With but few exceptions, steel is capable of hardening and is malleable at some temperature.

Cast or pig iron contains, as a rule, between 2.00 and 4.00 per cent of carbon, but is not malleable at any temperature.

From these definitions, therefore, it is seen that steel is the alloy between cast and wrought iron.

Various Processes Used

To obtain the physical and chemical properties needed for the numerous and almost totally different uses to which steel is put, several processes are employed in the conversion of the iron, scrap, and other raw materials into steel. The most important of these are the "Bessemer," the "open hearth," and the "crucible" processes. The first of these, named after its great inventor, the late Sir Henry Bessemer, is the method by which the majority of cheaper steels are manufactured. Accordingly we find the great tonnage of rails, structural shapes, shafting, and the lower grades of sheets and wire, produced in this way. The open hearth process furnishes the steel for springs, shovels, the better grades of wire, forgings, plates, and other articles, in which a higher grade of material than Bessemer is required, yet a grade not so fine as Crucible. When the highest grade of product is desired—such as edge and cutting tools, surgical instruments, razors, saws, die blocks, etc.—steel from the crucible furnace is utilized.



MOLTEN IRON BEING POURED FROM THE MIXER INTO LADLES.
It is in this vessel or furnace that the iron is mixed uniformly, previous to being used in the open hearth steel furnaces.

The Crucible Process

Crucible steel is made in much smaller quantities than the other forms of steel, the endeavor being to obtain quality rather than quantity. Consequently it is a very high-priced steel, the finer grades selling as high as sixty to eighty cents a pound.

The mixture for melting, consisting of definite and carefully weighed amounts of certain grades of wrought iron, blister bar, alloys, and scrap, according to the grade of steel desired, is packed in pots varying in capacity from 50 to 150 pounds. These pots are usually composed of plumbago and German clay, although in England a clay pot is almost altogether used. The life of the plumbago pot varies according to the manner of treatment, the mixture of materials melted within it, and the quality of the pot itself; but on a rough average it might be stated that each can be used three times.

The pots being filled, and a cap placed upon each, they are lifted one by one and placed in the furnace.

Although the crucible process is one of the oldest, but little advance has been made in its operation. The furnaces of to-day and the methods employed, are practically the same as those in vogue during the times of our forefathers in 1789.

The furnace proper consists of numerous holes, varying in number according to the size of the furnace. In Amer-

ica the furnaces usually contain from four to ten holes, six pots being placed in each, three abreast and two deep. The pots rest upon a thick layer of coke dust, which is able to withstand a very severe heat without becoming spongy or liquid, the coke dust making a very firm yet easy rest for the pots. Each hole is provided with three covers, which are easily removed by means of a lever.

The furnace being thus charged, and the covers placed over the holes as closely as possible, the gas and air are permitted to enter. Rushing through the superheated chambers on one side of the row of holes, they meet and pass through the flues into the furnace.

Darting around the pots, this heated gas, which rises in temperature to about 3,000° F., finally passes through the opposite flues into the chambers on the opposite side. Circulating through these and thoroughly heating the same, it finally passes up the stack.

The pots are subjected to this terrific heat for two and a-half to three hours, when the melter, by means of an iron rod, pushes the caps of the pots aside to ascertain whether the mass is melted. When melted it is still left in the furnace, in order to boil out any gas which might be held in solution. This is termed "killing" or "dead melting." Having been "killed," the molten steel is ready to be cast.

How the Workmen Make Ready

In preparation for this work of casting, the men wrap their legs with carpets, rubber, etc., and soak themselves with water. The cover is drawn from one of the holes; and the "puller out," dressed as above described, stands over the furnace or hole, and by means of a pair of tongs pulls the pots out, one at a time, carrying them to the moulds, which are standing in the casting pit at the end of the floor. There the molten steel is poured into the moulds, which stand upright. As a rule, the moulds are of one-pot capacity; but, if larger ingots are desired, larger moulds are employed, the metal being obtained from several pots. Care is taken that the stream from the two pots is not broken, the liquid flowing continually. If this is not done the result will be a defective ingot.

The pots, if in good condition, are refilled, and placed back in the furnace. When the steel in the moulds has solidified, the moulds are unfastened and the hot ingots drawn out, ready for another department.

Handling of Crucible Steel

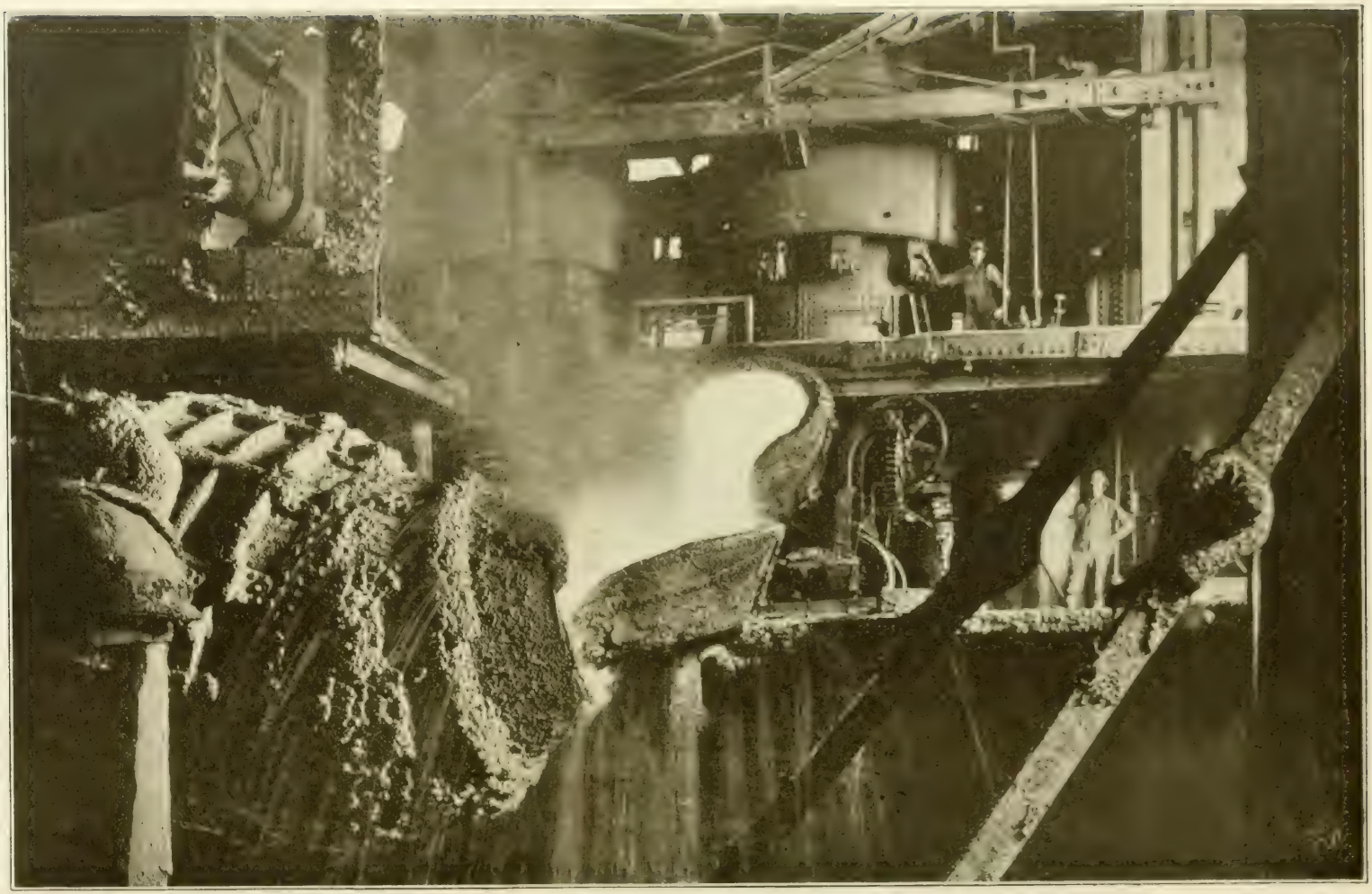
The ingots are first taken from the casting pit or furnace to the "tempering" department. Here, by means of a sledge, the top or piped end of each ingot is knocked off in order to expose the grain of the steel, thus permitting an experienced eye to ascertain the carbon percentage of the same. In mild ingots, and those of a shape or size that will not permit of the ends being removed, a small corner of the ingot is chipped off.

The formula being marked upon the ingot, indicating the grade and the percentage of carbon, the ingot is then either piled in stock or taken directly to another department. Unlike the products of other processes, many grades of crucible steel are first welded—hammered at a high heat—thus refining the grain and destroying many of the blow holes or gas holes. The steel is then usually taken directly either to the hammer shop or to the mills. In either case the billets are reduced to the desired shape and size by being passed between rolls or under the rapidly moving dies of the steam hammers. The completed billets go to the "inspection house," where every bar of steel is examined minutely for all defects before being weighed, marked, and shipped.

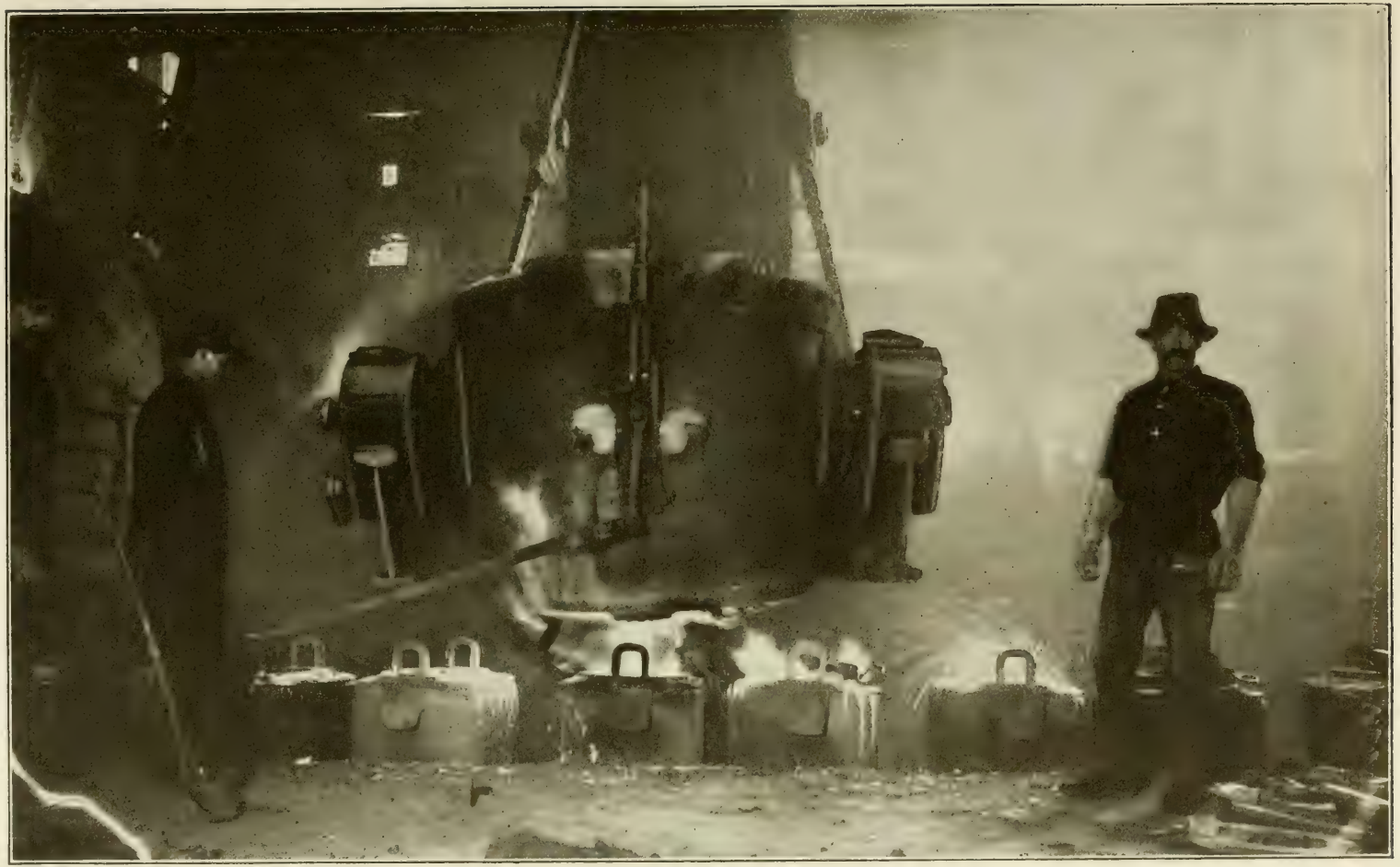
The Open Hearth Process

The open hearth process furnishes about one-third of the steel used to-day. It has, for the past few years, been rapidly crowding Bessemer steel out of the market, as well as making great inroads in the fields formerly occupied by the crucible product.

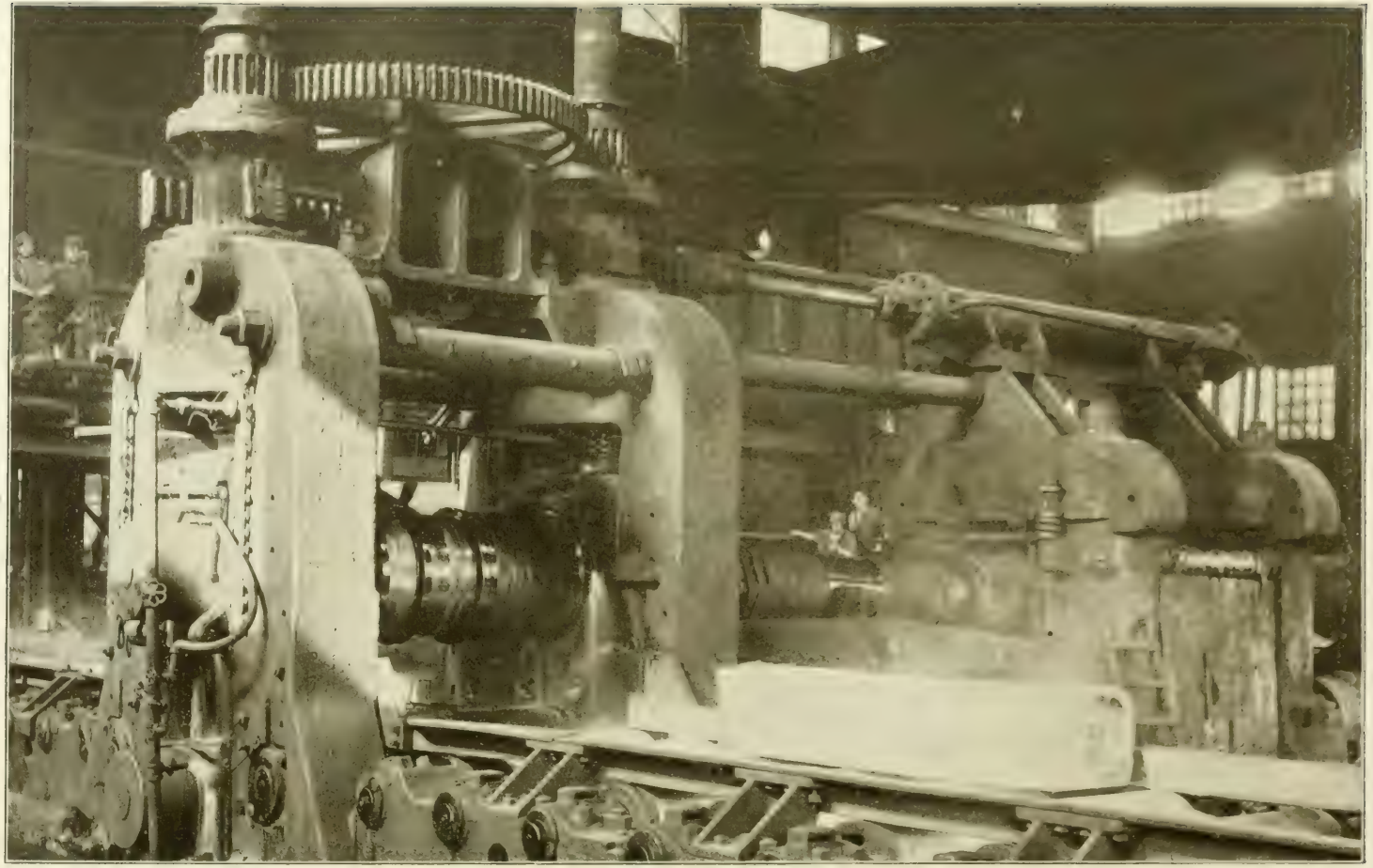
The cause of this popularity, on the one hand, is that the stock, in many cases, is much sounder and gives better satisfaction than Bessemer—which naturally justifies the small additional expense. On the other hand, experiments



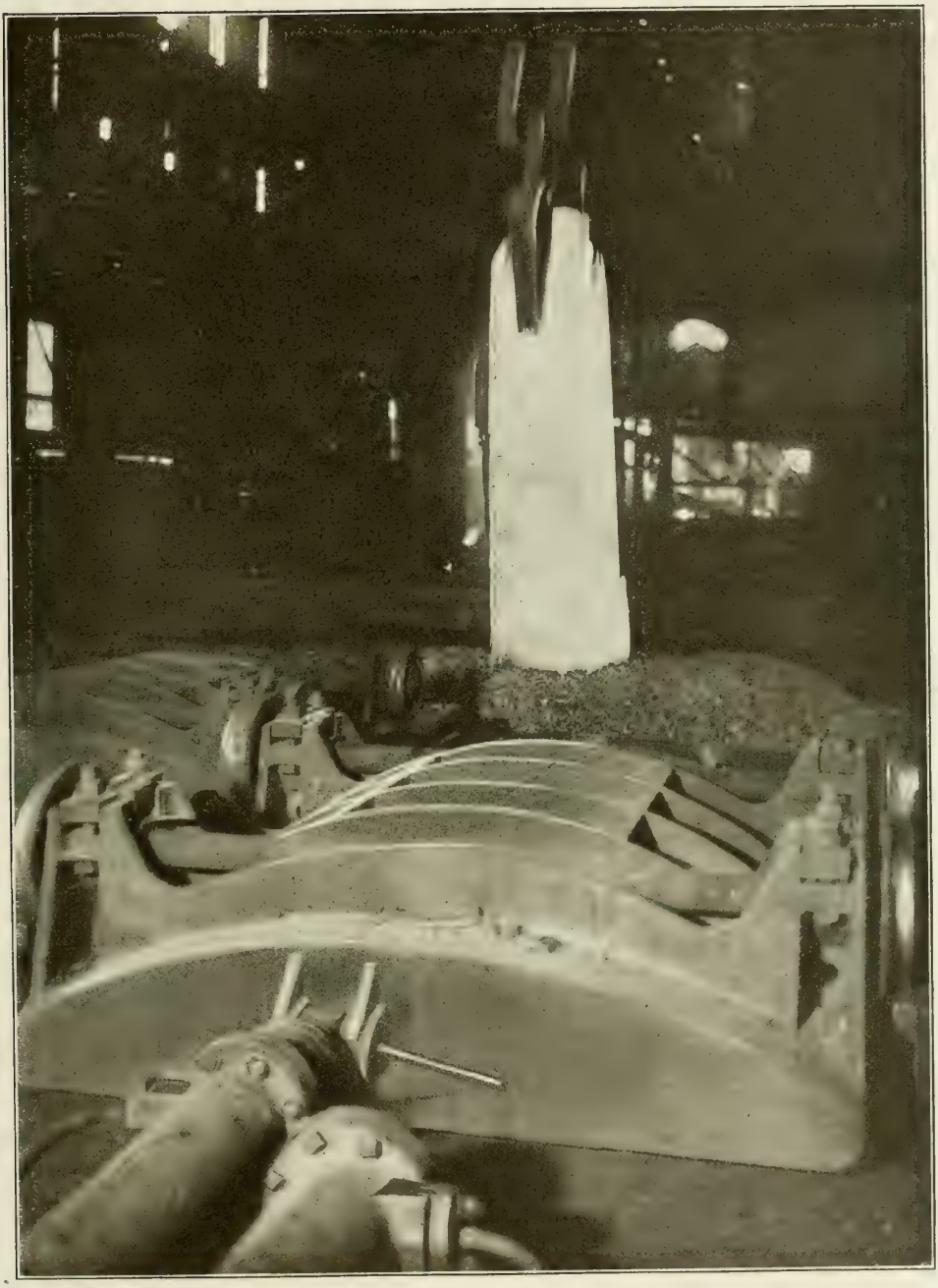
FILLING THE BESSEMER CONVERTER WITH WHITE MOLTEN IRON, TAKEN DIRECTLY FROM EITHER THE BLAST FURNACE OR THE CUPOLA.



CASTING THE MOLTEN STEEL FROM THE LADLE INTO THE MOULDS.



A PIECE OF WHITE-HOT STEEL, WEIGHING 6,000 POUNDS, ENTERING THE ROLLS.



RAISING A WHITE-HOT PIECE OF STEEL FROM THE SOAKING PITS BY MEANS OF A POWERFUL ELECTRIC ARM.

This giant hydraulic crane, clutching in its jaws the white-hot ingot of steel, well illustrates the titanic apparatus used in great steel mills. In comparison with the enormous weights to be lifted and the tremendous heat to be dealt with, man is so puny that, of necessity, almost everything must be done by machinery, human fingers being necessary chiefly to raise and lower the levers and press the buttons which set the great machines in motion.

have proven that the lower grades of crucible steel can readily be manufactured by the open hearth method without any visible difference except for the very much decreased expense.

The furnaces in which open hearth steel is made, vary in size from five to fifty tons' capacity, the modern ones being of the latter tonnage. In design

A Car of Ingot Moulds.

they consist of an oblong brick structure alike at both ends. As in the case of the blast furnace, every particle of heat is caught and utilized. The air and gas, entering one end of the furnace and being thrown down upon the charge or "bath" by the curvature of the roof, dart across the furnace or hearth, making their escape through the ports on the opposite side, into the reheating chambers below. Thoroughly heating these, they finally pass up the stack. At regular intervals the air is allowed to circulate through the previously heated chambers prior to its entrance into the furnace, the escaping gases entering and heating the opposite or cool set.

The bottom or hearth, which converges to one point in the center of the furnace, thus facilitating the tapping, is usually lined or covered with a special material, dependent upon the nature of the chemical reaction desired. If a basic reaction —one in which some of the foreign substances are eliminated or reduced—is desired, a basic lining is placed upon the bottom. This usually consists of dolomite, although magnesite, chromite, and lime have been used in a few cases. These materials are able to withstand the strong basic slag. In the acid process, where the phosphorus and sulphur are but little affected by the chemical reaction, a sand lining is usually employed.

All Done by Machinery

During the past few years the open hearth plants have been entirely revolutionized. Under the present methods, wonderful mechanical devices enter into the operation at every turn. Accordingly, whereas, in former days, the pig iron was charged in a cold state, to-day it is almost universally poured into the furnace in its maiden liquid condition, thus economizing in heat, labor, and time in melting.

By the present methods, the large ladles of iron are carried directly from the blast furnace to the mixer. Here they are lifted bodily over the opening on top of the mixer. They are next inverted, and their teeming contents gradually poured in. Receiving as it does the products of the various casts of the blast furnaces, the mixer acts as an immense storage room, at the same time thoroughly mixing the several casts together, forming a uniform, homogeneous mass.

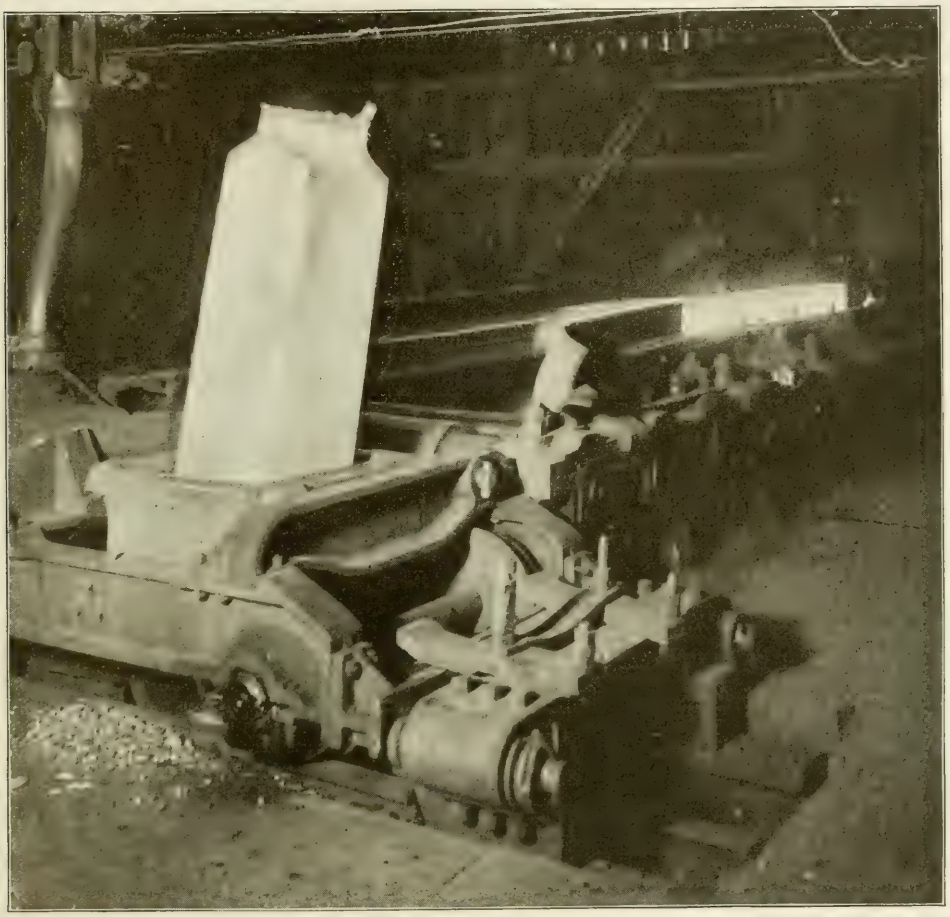
When the iron is required in the open hearth or Bessemer departments, the large furnace is swung down upon its axis, permitting the molten metal to flow through the mouth into the ladles standing upon the floor below.

The open hearth furnaces, being the scavengers of the mill, are charged with all manner of scrap, old castings, rails, etc. As required, the desired quantity of each ingredient is placed in large cast-iron charging boxes similar in shape to a bath-tub, having a capacity of about 5,000 pounds each. These in turn are picked up and placed sidewise upon small, flat, narrow-gauge cars. When a sufficient amount to make a charge has thus been collected, the cars are drawn into the building, close to the front of the furnace. The furnace being ready for charging, the immense electric charging machine is brought into action. By means of this powerful device, one man, who manipulates the electric levers, can charge a furnace in less than twenty minutes, whereas, a few years ago, this was

the work of several hours for a large army of men.

The "acid" process is practically no more nor less than a case of oxidation, in which the phosphorus and sulphur of the charge are not removed, but the steel continues to hold almost every atom of these ingredients as they were present in the iron, scrap, and ore. So the composition of the raw stock, as regards these two elements, must be positively ascertained; and if a low phosphorus and sulphur steel is desired, the charge must be regulated accordingly. On the other hand, the carbon, manganese, and silicon contained in the raw stock are oxidized.

In this process the iron is usually charged first (though many plants charge the stock or scrap first), care being taken to insure its equal distribution over the bottom and on the banks or sides, the scrap being placed as evenly as possible over the iron, thus permitting the scrap to melt first and trickle over the hot iron, the latter being thus protected by the carbon and silicon, for which oxygen has a greater affinity than for iron.



WHITE-HOT INGOT OF STEEL BEING DELIVERED TO THE ROLLS.

After the metal becomes molten, a covering of slag forms upon the bath, due to the sand from the pig iron if the iron has been charged in the form of sand-cast pigs, and to the silica produced by oxidation. If the pig iron is free from sand and low in silicon, the slag will be very thin and of a basic nature, which would ruin the bottom. As a result, an

addition of silica would have to be made. If the opposite, iron is usually added, which forms an iron oxide.

Tests Made by the Eye

When the entire bath has been melted, iron ore is added at intervals, thus oxidizing the carbon, manganese, and silicon, and forming silica and oxide of manganese, which pass into the slag, while the carbon forms carbonic oxide which unites with the flames. The carbon thus causes the entire bath to bubble, which exposes the metal to the flames and keeps it hot. The metallic iron which is set free by the union of oxygen with the silicon and carbon, is dissolved by the bath.

At intervals a small cup is placed in the bath, and a test of the steel poured into small test ingots about one inch square in cross-section. After chilling in water, these ingots are broken, and the percentage of carbon is determined by the eye. If too high in carbon, the molten mass is oxidized still more; if too low, iron is added.

When the desired point is reached, ferro-manganese or some other recarbonizer is thrown into the bath, the furnace being tapped instantly and the steel permitted to run into the ladle. If this is not performed at once, the manganese will become oxidized through the intense heat of the flames and the slag.

The Bessemer Process

Although there are two kinds of Bessemer steel, the "acid" and the "basic," the acid process is the one almost altogether employed, the conditions in this country proving adverse to the basic. In a nutshell, the Bessemer process consists in forcing a strong blast through molten pig iron, thus oxidizing the carbon and leaving the iron free from the same. In order to recarbonize it to the required percentage, ferro-manganese, coal, or Spiegel is added, while the molten iron is being poured into the ladle.

The furnace itself consists of an iron-covered, brick-lined, pear-shaped vessel suspended upon standards by means of two trunnion arms attached to the converter. By this means the vessel can be rotated almost seven-eighths of a revolution, thus permitting it to be placed horizontally on one side to be filled, then perpendicularly or vertically to be blown, horizontally on the opposite side to be emptied, and upside down to permit the slag to run out.

Converters Spout Flames

The charge of five to twenty tons of molten iron, taken either from the mixer or from a cupola, being introduced, a strong blast of air of fifteen to twenty pounds' pressure per square inch is permitted to rush through one of the trunnions into the small chamber in the bottom of the vessel. From here it makes its exit into the interior of the vessel through the numerous small holes in the false bottom. At the same instant, the vessel revolves on its mighty arms and points its infernal mouth skyward, as though hurling the hottest defiance in the very teeth of the sleeping night. Here it remains for several minutes, the first four or five minutes witnessing a flame of light yellowish-red color and a shower of glittering sparks. During this stage the uncombined or graphitic carbon passes into combined form, the silicon being oxidized to form silica, which unites with ferrous and manganous oxides to form slags. This change is accompanied by a rapid rise of temperature, the flames becoming brilliant, large, and of a very dense yellow color. The metal now boils, the agitation being due to the formation of carbonic oxide from the oxidation of the iron by the oxygen of the blast. During this stage the pressure of the blast is reduced.

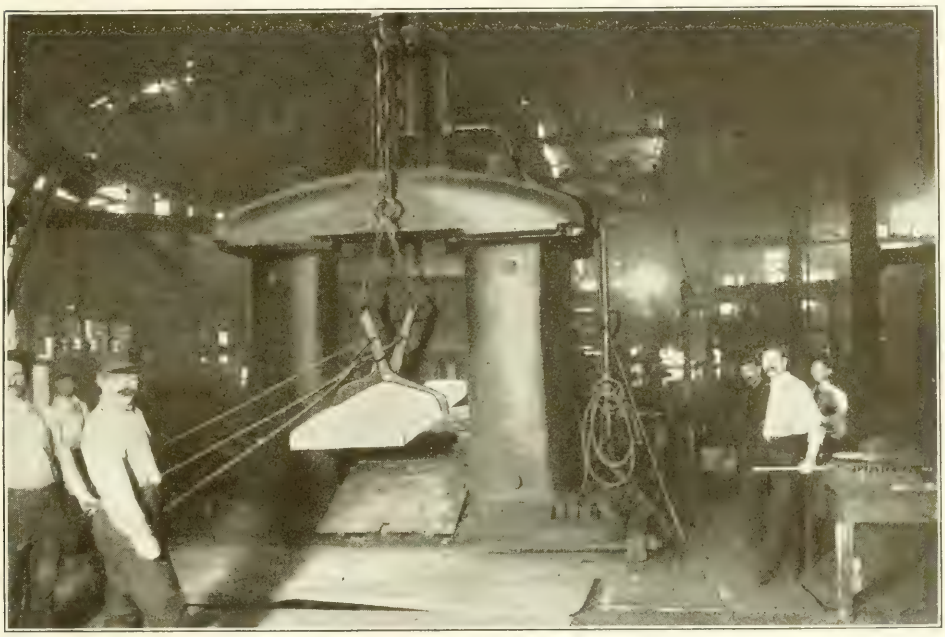
The next stage in the process is signaled by the pale rosy hue of the flame, which becomes more transparent and less brilliant, together with the small number of sparks now issuing from the vessel.

Ready for Last Steps

These are signs that the carbon is nearly eliminated and the contents of the vessel almost ready for the last steps. When the flame drops, the vessel is at once turned down, and the blast shut off. Its contents are then poured into a ladle;

and at the same time, a certain percentage of Spiegel or ferro-manganese is added, in either cold or liquid state, to recarbonize the metal to the required amount. The phosphorus and sulphur in the steel are practically the same as in the iron before blowing, the silicon, carbon, and manganese having been reduced.

Quick as a flash the vessel is turned over, filled, and the operation repeated; the brimming, fiery ladle containing the molten steel being lifted by the strong iron arms of the hydraulic crane over a set of moulds, into which the newly born steel is poured. As soon as filled, a brisk little engine takes hold of the long row of cars upon which the freshly cast steel ingots and their moulds are resting. With a warning toot, it goes puffing away amid the sparks, flames, and din, to the open yard beyond.



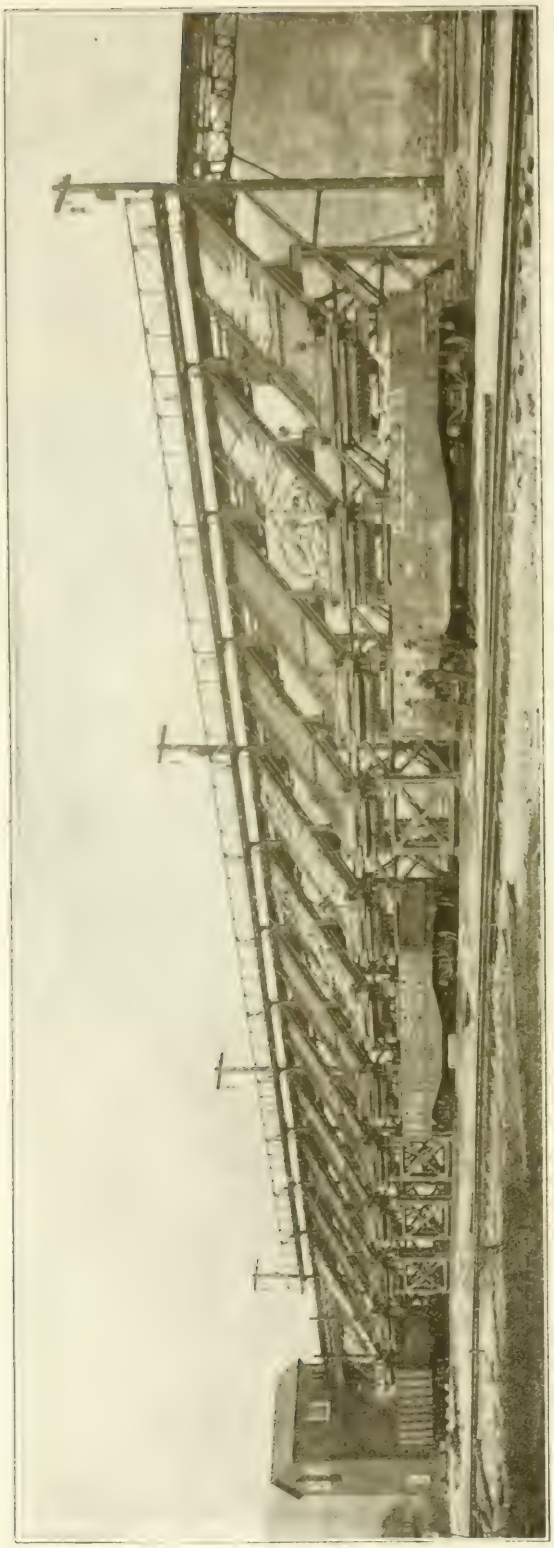
SHEARING THE LARGE SLABS OF STEEL WHILE RED-HOT.
These will be re-rolled into the finished sizes by another and smaller mill.

Handling of Bessemer Steels

After the moulds have been filled with the molten steel, they are taken to the "stripper," which is usually next to the open hearth or Bessemer buildings. Here the cars containing the moulds are run under a large electric crane, which is so constructed that two arms fit over a projection on each side of the mould. As the mould is lifted, a central ram presses upon the top of the ingot, leaving the ingot upon the car, while the mould is picked up and placed upon a car located upon the next track.

From here the red-hot ingots are taken to the heating furnaces of a plate or "blooming" mill, where they are heated to a higher temperature for rolling. When of the proper heat, they are lifted out of the large furnaces by means of an electric crane and are carried to the table.

The latest method of transferring the ingots from the soaking pits to the rolls is by lifting them one at a time from the furnaces, as above stated; but, instead of carrying them to the rolls by the crane, they are placed on end on a specially constructed cast-iron car operated by electricity. The car is then run to the end of the table, where a lever attached to the rail throws the body of the car towards the rolls, the ingot falling upon the table. The car then returns for another load.



A NEW METHOD OF LOADING STEEL BILLETS.

After the steel is sheared, it passes up an incline and into the bins, where the billets are cooled and, when ready, are permitted to fall into the cars.

Rolling the Steel Ingots

The rolls rotating, the ingot is advanced towards the large rolls through which it is to pass. Here the race begins. Faster and faster revolve the small rolls, carrying the heavy solid block of steel at a terrific pace towards the yawning mouths of the large rolls. Through these it goes with a terrible protest, throwing its scale in every direction. The ingot having reached the other side in a somewhat flattened condition, the mighty engines stop and reverse at a break-neck speed, the table again carrying the ingot between the rolls. Backward and forward it is hurled, each pass reducing its shape and thickness until of the proper dimensions, when it is carried between the sharp and powerful teeth of the shears which cut it to the desired lengths.

If billets are being made, they are conveyed as rapidly as sheared, by means of an endless chain, up an incline, to the top of the bins. Here is a long, narrow platform over which the chain travels. Along the side of the platform are the steel bins, with gates at both ends. The bottoms of the bins slant at an angle of sixty-five degrees from the chain to the ground. The billets, being carried up the incline and along the narrow platform, come in contact with the switch or upper door of the bin, which opens and allows them to enter. One after another they go tumbling down; and when the bin is filled, that gate is closed and the door of the next bin opened. When the billets have cooled, the lower gates are opened, and the billets fall into the cars beneath. Thus the steel is made, taken from

the moulds, heated, rolled, cut, and loaded, without the actual touch of man!

In many cases the large blooming mills simply cog the ingots down to a size convenient for the smaller mills which finish them. Many of the plate mills roll the plate direct from the ingot, the breaking down and finishing being combined in one operation.

No Scene So Appalling

No poet—not even Dante in the *Inferno*—has ever conceived anything so appalling to the unaccustomed as the nightly scene in a great steel mill in operation. A forest of tall, black stacks vomit red flames to the sky; out of the open mouths of the converters, shoot torrents of red and yellow and green fiery gases, throwing a lurid light over everything for squares around; everywhere there are showers of sparks falling through the night and the eye-dazzling brilliancy of molten, incandescent metal, flowing like water from one great vessel to another; here and there stand the workmen, like black, grimy pygmies, half naked and half heavily wrapped to protect them from the blistering heat. And over all, sound the groan and tumult of the titanic machinery as it rends and crushes the great steel ingots.

Fate

ONE ship drives east and another west,
With the self-same winds that blow;
'Tis the set of the sails
And not the gales
Which tell us the way to go.

Like the winds of the sea are the ways of fate,
As we voyage along through life;
'Tis the set of a soul
That decides its goal,
And not the calm or the strife

PART OF WHAT WAS A FARM IN SUMMER TIME

In the Water-Forest of the Spree

Strange Region in Germany Where Boats and Skates are the Customary Means of Travel

By FRITZ MORRIS

ONE of the most interesting regions in the "Old Fatherland" is the so-called "Spreewald," the Forest of the Spree, situated not far from the German capital, in the Province of Brandenburg. Populated by the descendants of the once mighty tribe of the "Wenden"—one of the few remnants of the Slavic race in Germany—they stubbornly defy the influences of modern times and retain in many respects the whole charm of bygone centuries. That stretch of land on which they reside—the most remarkable one along the Spree between Berlin and the source of the river—broadens into a wide and marshy plain, broken in every direction by hundreds of meandering streams and waterways here and there forced by human skill into narrow channels. This plain is divided into the "Lower" and the "Upper" Spreewald, the first ending near Lubben, the latter beginning near Lubbenau, famous for its cucumber culture.

The most attractive feature of the Lower Spreewald is its forest, consisting of oaks and alders of magnificent growth; while in the Upper Spreewald, the old "Wenden times" are still alive in the construction of the dwelling-houses, in the language of the people, in their curious customs and costumes, and in the family life of the inhabitants. Each village is a little Venice, every house a little island; and these islets are connected by bridges sufficiently raised to allow boats to pass under them. Most of the houses, with their barns and stables, rest on piles; and there is generally a strip of artificial *terra firma,* either in front or at the rear of every building. By means of these land strips and of the bridges, the slender land communication is kept throughout the district; but most of the business and amusement is carried on through the canals, which not only form the main highways but penetrate and cross

GOING TO CHURCH.

and re-cross the whole region. It is on these lagoons that all traffic is conducted in boats, during the period from spring, when the last vestiges of frost and ice are disappearing, until the end of autumn. You see the letter-carrier shoot up and down the canals, performing his duties in his frail craft; the police glide leisurely along the banks, watching everything going on; peasants bring the products of their toil to the nearest towns; children go to and from school; young mothers, dressed in their Sunday clothes, are rowed to church, carrying in their arms a small, queer-looking bundle from which two large eyes in a tiny face stare at the stranger in wonderment — baby is going to be baptized, an important moment with this strongly religious people.

Here comes a gay wedding party, and for quite a long while before you see them, you hear the laughing and the shouting of the girls and their male companions; a large boat, decorated with richly colored ribbons, streamers, and garlands of flowers, rounds a wooded corner. There is the blushing bride, a splendid specimen of rustic womanhood, with her short voluminous skirts, and that peculiar headgear, under which her dark, thick tresses flow down to the knees. There is the sturdy bridegroom in his long, old-fashioned coat with shining brass buttons and high heavy boots covering half his leg; while there are the rosy-cheeked bridesmaids, charming pictures of ruddy health, flirting assiduously with the "best men," all in the big barge-like boat.

FISHING WITH NETS THROUGH THE ICE.

A FUNERAL PROCESSION ON THE

Here is another picture by way of contrast—a dozen or more boats, one after another, gliding noiselessly in sad procession through the canals. The first boat bears the minister and the flower-covered coffin; then come the relatives of the deceased, followed by his friends, the women in long, white, strange-looking veils, and all singing those melancholy, monotonous dirges which their grandfathers and grandmothers used to sing on these funeral occasions.

All this coming and going, this traffic and business, is performed without the least noise. There are no ear-splitting whistles, no rattling and rumbling of heavy trucks, no hissing and thundering of locomotives, no whizzing and whirring of automobiles, no clanging of gongs—not one of the thousand and more kinds of noises that go to make up the terrific, nerve-wrecking din of big cities and crowded centers of life and industry. But for the merry laughter of children at play and the noise of fun-loving young people, you would not hear a sound as you idly drift under the overhanging masses of forest trees, where, as Shakespeare has it, "the twin sisters of Silence and Twilight keep their noonday watch, and all the cheated hours ring vespers."

THE LETTER-CARRIER

One of the old pastimes still kept up in the larger villages of the Spreewald, is the *Spinnstuben-Gesellschaften,* that is, Spinning Parties, the members usually made up of ten and seldom exceeding fifteen girls. All the families represented take their turn in entertaining, generally giving up the best room in the house for the purpose, the girls themselves furnishing the refreshments. For, while making the wheels of the spindles turn merrily round, the spinning work is not the main thing. After two or three hours, the youths of the village appear

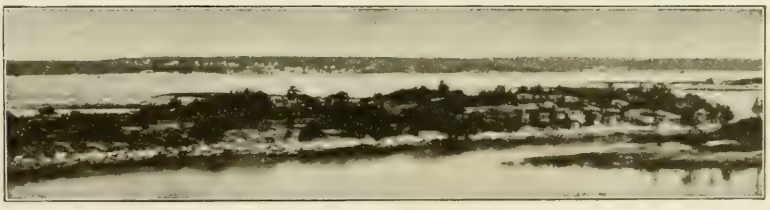
SPREEWALD, NEAR BERLIN, GERMANY.

on the scene, and, having been treated, start in to play, sing, dance, and generally make merry. Each party has its female conductor, the *Kantorka,* to whose rulings all the girls and boys must submit.

On several occasions they have queer celebrations, as on *Fastnacht,* when they march in solemn procession over the ice and snow-covered waterways, to the *Herrenhof,* the near-by residence of one of the wealthy, aristocratic, land-owners of the district.

Winter life in the Spreewald is quite as interesting and picturesque as that seen in summer. Where boats are gliding during the other months, there are sledges darting over the frozen waters, young people enjoying their outdoor sports on snowshoes or skates; while the big trees, with icicle-laden branches glistening and flashing in the sunshine, form a wonderful frame to this interesting picture of life, traffic, and amusement.

So the Spreewald—with its queer, quiet people going their own ways, and living, as it were, far from the outer world, though near the mainroad of it; these pretty women and girls in their traditional and attractive costumes; these strongly built, good-looking men; these old homesteads, every one of them a charming motive for an artist—the Spreewald, with its language and customs, remnants of bygone centuries, presents itself as a piece of romantic life seldom seen, rarely visited by Americans, yet unequaled in all the world.



WHERE HISTORY

Faneuil Hall, Boston, Mass., the "Cradle of American Liberty," was a famous meeting-place for American patriots during the Revolution. It was originally a market house, with a hall for public meetings, built by Peter Faneuil, a merchant, in 1740. It was rebuilt by the town of Boston in 1763, after having been destroyed by fire two years before. In 1805 it was considerably enlarged.

WAS MADE

The Old South Church, Boston, Mass., was built in 1729 on the site of an earlier meeting-house. Many of the most stirring meetings of Revolutionary times were held within its walls. The British used it as a riding school in 1775, but afterwards restored it to religious uses. From 1729 to 1872 the annual election sermon was delivered there. It now contains a collection of historical relics.

CLEARING LAND FOR THE TEA GARDENS.

Great Chance for Tea Farmers

Success in Growing Tea in South Carolina Points Way to Important New Industry

By FREEMAN TILDEN

AMERICANS are essentially a nation of coffee drinkers. In proportion to our population, we consume only about one-sixth as much tea as our British cousins, whether at home or in the colonies. Our people pay at retail something like $45,000,000 a year for tea, as against $155,000,000 for coffee. Yet there is little doubt that the poor quality of tea which has come into the country has been a great factor in preventing an increased popular taste for what is, at its best, a delicate and healthful beverage.

The United States now excludes the worst trash of the tea trade, but our importations are still chiefly of cheap and inferior teas. Comparatively small consignments of better grades are imported for those who are able and willing to pay for them; and with this field before us, the question naturally arises, "Can tea be grown in the United States to compete with that from Asia and other favorably situated regions?"

Home-Grown Tea

In part, the question has been answered. This year 12,000 pounds of choice tea will be shipped from what is, at present, the only tea farm in the Western hemisphere. This farm is at Summerville, South Carolina. In the face of difficulties that at times seemed insurmountable; but on the other hand, with the kindly assistance of the United States Government, the Summerville tea farm has grown to a point where it can offer serious competition with the best grades of tea shipped from China, India, Formosa, or Java. But, above all, it has been demonstrated that, barring the question of labor, the finest tea can be successfully grown at home; and there is noth-

ing that gladdens the heart of an American more than the discovery that he can enter into competition in a field hitherto denied him.

The Labor Factor

The question of labor is a serious one. As this item costs several times as much here as in the Orient, it may safely be concluded that, without a duty on foreign teas or a bounty on the American product, competition in the cheaper grades will be impossible. But at the very inception of the experiments in Summerville, it was distinctly stated that all ideas of success were based on the production of higher grades of tea, as being less the creation of cheap labor.

Here enters another important feature. In the struggle between Chinese and British Indian and Ceylon growers for supremacy in the tea trade, the introduction of machinery played the most important part. Labor was apparently cheapest in India, but not cheap enough to accomplish the overthrow of the Chinese producer and leave a margin of profit. Thus the conflict settled down to a trial of the machine against the man; and the Indian grower, armed with the latest devices, won. It is true that the delicate touch of the human hand can make artistic tea which cannot be duplicated by machinery; but for cleanliness and economy the mechanical method is far preferable.

At the up-to-date British tea estate, almost the entire process of tea-making—from the transportation of the plucked tea from the gardens to the factory, to the final boxing of the finished product—is performed by machinery. Only two processes remain for human hands. One, the plucking of the leaf, can never be superseded, as it requires discretionary power; the other is the culling-out of stems and other admixtures from the finished product.

This first American tea farm, though at first the tea was worked by hand, has finally installed the most perfect kind of machinery; and a Ceylon tea grower who visited the place recently declared that he had learned something of economy in making tea.

"SUGAR TEA," GROWN UNDER COCOANUT MATTING.

The labor used is nearly all negro labor. Boys and girls of school age are employed during the tea-making season in all branches of the work, and in the winter are at school on the premises under teachers specially provided for them by the owner of the farm, Dr. C. U. Shepard. In this manner a fine work is going on, the training of the hands

THE CHILDREN WHO PICK TEA LEAVES.

and the minds of the negro children being accomplished at the same time. With this labor it is hoped that American tea will be able to compete with foreign-grown tea of the finer grades. As far as the work has gone—and it certainly has gone past the experimental stage—the possibility of such competition has been demonstrated. Every pound of the product is engaged in advance, and the only question that confronts the growers now is how to meet the demand for American tea.

Long Struggle Crowned with Success

It is interesting to note the struggles through which the tea industry in the United States has passed, in coming into being. Of course, from the very first, Yankee activity was awakened by the similarity of flora, of climatic conditions, and to some extent of cheapness of labor, between certain sections of our own country and those lands where tea-growers were making fortunes. A hundred years ago, at the Middleton Barony, now in decay on the Ashley river, near Charleston, South Carolina, the tea plant was introduced, and flourished as a garden plant. Mr. Junius Smith, in the forties, at Greenville, in the same State, experimented with tea culture; and ten years later the Government collected tea seed in Asia and distributed it in the South Atlantic and Gulf States.

But these experiments, while they showed beyond a doubt the adaptability of the tea plant to this climate, did not prove that the tea culture could be carried on with profit. Consequently an experiment station was established at Summerville by the Department of Agriculture, in the last quarter of the nineteenth century. For various reasons this experiment was a failure; and it was not until several years afterward that the present tea farm was gotten under way and was made a paying proposition.

Gathering and Manufacture

In summer the casual visitor to the Summerville tea farm sees only the acres of roses, japonicas, azaleas, and other flowers and shrubs; and the place seems to be only a well-kept private park. But penetrating beyond, the visitor comes

ONE OF THE TEA GARDENS, WITH PICKERS AT WORK.

upon the plots of tea bushes, all trimmed to an even height. The children pass from bush to bush, selecting the young and tender shoots, and nipping them off dexterously without tearing the remaining stems. There is only one way to judge the proper leaf for plucking, and "green," or non-oxidized tea; and "black," or oxidized. Each of these classes is subdivided into numerous sorts conditioned on the degree or method of oxidation. For the manufacture of what is called "Oolong" tea, the leaf is spread on large trays and allowed to wither from

SINGLE TEA BUSH IN GOOD BEARING.

that is by the sense of touch. Of two leaves of the same size and color, one may be suitable, and the other too tough. This plucking of the leaf demands careful and constant supervision, for upon the selection depends the cost of manufacture.

The tea is divided into two classes—

twelve to twenty-four hours. When the leaf has attained the desired degree of pliability (when it feels like an old kid glove), it is put into the rolling machines, and the oily cells are broken up, their contents being distributed over the surface of the leaf.

Incidentally there is given to the leaf

that twisted appearance which is so familiar. The twist is merely incidental and has nothing to do with the quality of the tea, as some people think, except that if much flat leaf is shown in the finished product it may indicate that the leaf is tough. After the leaf has been sufficiently rolled to make available the aromatic oils and theine, the tea is taken to the firing machines for the final oxidation; and when the firing has been completed, all the valuable portions of the leaf substance are found dried upon the surface of the leaf.

In the making of green tea, efforts are made to prevent any such oxidation of the leaf taking place. As this starts almost as soon as the leaf is plucked, it requires great skill and care to defeat Nature.

At the Summerville tea farm, there is grown, under cocoanut matting, a distinct variety such as is known in Japan as "sugar tea." So far as known here, there is only one other tea garden in the world where this kind is grown—that of the Imperial Court of Japan. Of exquisite delicacy, and sweeter to the taste than teas grown in the open sunshine, this variety demands, of course, the highest price in the tea trade, and very little can be put upon the market.

As a result of the successful experiment with tea-growing at Summerville, there must inevitably come other and larger plantations throughout those portions of the Southern States where climate and soil are favorable. Already companies have been formed for the establishment of farms in Georgia and in Texas. The only difficulty will be in convincing the tea-drinking public that cheap tea is poor tea. In China and Japan today, the home demand for grades of tea that cost ten dollars a pound is so strong as to leave very little of the product for exportation. The Summerville experiment has proven that a first quality of tea can be produced in the United States under labor conditions not nearly so favorable as in the Orient, yet at a price which will bring the best grades within the reach of all.

In the development of the growth and manufacture of tea, the greatest interest is being taken by the Department of Agriculture. The Summerville farm is a government experiment station.

Sympathy

LIFE'S sterner moments call for patient skill;
Its blessings flow from streams tide-washed afar;
He only can the place of friendship fill
Who has been wrecked beyond some harbor-bar.

BEFORE OPERATION.

The doctor holds a blue lamp and reflector in his left hand, and a blue veil in his right hand.

Put to Sleep by Blue Light

Minor Surgical Operations Performed without Pain to Patients Under Influence of Colored Rays

By FRANK C. PERKINS

Consulting Electrical Engineer

PROF. C. REDARD, a well-known physician and scientist of Geneva, Switzerland, has aroused considerable interest by the announcement of his discovery and successful use of an electric anæsthetic. The illustrations show the doctor in the act of administering the anæsthetic to a patient. The apparatus employed is simple, consisting of an electric incandescent lamp, with a blue globe and a reflector, together with a blue veil used for covering the face of the patient and excluding all traces of sunlight while the blue rays are doing their work.

Doctor Redard claims that after the patient has attentively fixed his eyes on the blue rays for two or three minutes he will become unconscious, after which a small surgical operation—such, for example, as the removal of a tooth—can be performed without causing the patient the slightest pain.

The awakening from the effects of the rays is quite gradual, and no dangerous or even unpleasant symptoms are noticed.

Experiments have shown that green and violet rays produce somewhat the same effect as the blue, but not to the same extent.

The blue light—a 16-candle-power incandescent, with a blue bulb, is effective and easily obtainable—should be held about six inches from the patient's eyes.

Further experiments are now being made to determine whether or not the new electric anæsthetic can be adapted to use when serious operations are necessary.

The idea of Prof. C. Redard's discovery came to him by accident. He was conducting a series of experiments with

PATIENT'S HEAD AND BLUE LAMP COVERED WITH VEIL TO EXCLUDE ANY STRAY DAYLIGHT.

different colored lights and noticed that when a blue light was in use his assistant was uniformly attacked by drowsiness. With this as a starting point, he dropped the old experiments and began to try the effect of the blue light when administered directly and under the most favorable conditions. He soon discovered that the slight drowsiness caused by continuous working in the blue rays became a quick unconsciousness—a sort of self-hypnotism—when other light was entirely excluded and the eyes fixed on a brilliant and concentrated blue light. Simple experiments soon showed that when the patient is in this condition he is entirely insensible to a degree of pain which, under normal conditions, would be excruciating.

Professor Redard believes that he will eventually be able to devise an electric apparatus which may be successfully used even when capital operations are to be performed.

Line of Least Resistance

A CROWD of troubles passed her by,
As she with courage waited;
She said, "Where do you troubles fly,
When you are thus belated?"
"We go," they said, "to those who mope,
Who look on life, dejected;
Who weakly say good-by to hope;—
We go where we're expected."

A HERD OF YAKS JUST COLLECTED IN CENTRAL ASIA.

Romance of the Wild-Beast Trade

By WILLIAM G. FITZ-GERALD

Author of "Travel and Exploration in Central Australia"

A VERY lucrative if somewhat speculative industry is the traffic in wild animals — the stocking of the zoölogical collections of the world with the lion, the tiger, the elephant, and the rhinoceros, with great reptiles, birds of prey, etc., as well as the supplying of those important markets, the circus, the traveling menagerie, and the entertainment promoter in search of novelties in performing animals.

This most curious and interesting trade is in the hands of very few dealers. Indeed, beyond Carl Hagenbeck of Hamburg, William Bartels of New York City, and W. S. Cross of Liverpool, there are hardly any who count. This is not surprising. The stock is most difficult and expensive to procure, and equally so to maintain. Its mere existence calls, not for square feet, but for whole acres of space; and when one considers that a single elephant will make away with 750 pounds of green stuff in a day, he begins to realize what a serious matter it is to keep "a stock" of wild beasts on hand at all.

Call at Hagenbeck's business office, and you will be shown accounts dealing with the food-bill of the animals on hand. You will notice among the year's items 460 tons of horse-flesh; tens of thousands of chicken heads; hundreds of tons of fish; whole train-loads of hay, vegetables, fruit, sugar, bread, milk, and crackers; hundreds of thousands of eggs; besides wines, medicines, and many other items.

This vast emporium covers almost eighty acres. It lies on high ground in the suburb of Stellingen, less than an hour's drive from Hamburg's great docks. From it a hundred lions, tigers, and leopards are sold every year, and more than twice that number of bears, camels, and elephants.

The demand exceeds the supply. Almost all our great cities nowadays have some sort of zoölogical collection; whilst abroad are men like the Duke of Bedford, who accustoms the delicate giraffe to England's trying climate in the lovely park surrounding Woburn Abbey; the Hon. Walter Rothschild, who drives a team of zebras and has spent a fortune

on zoölogy; and the young Sultan of Morocco, whose political troubles do not interfere with his taste for polar bears. Mr. Hagenbeck recently sent $17,000 worth of wild beasts to Fez for this prince.

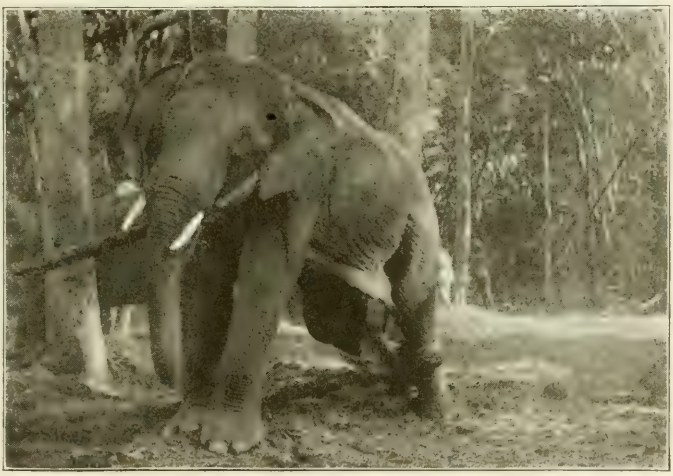
How the Animals are Caught and Marketed

For the catching of these huge and dangerous creatures, it will not do to depend upon native chiefs. Nor are professional ivory-hunters, like Mr. F. C. Selous, the great South African Nimrod, of much use. Mr. Selous kills his animals, and collects merely the skins for museums of natural history.

The wild beast dealers must perforce send out their own expeditions — necessarily a costly and systematic business. Mr. Hagenbeck often has as many as twenty white travelers out for him in remote corners of the Earth.

Natives are useful, of course. They bring to camp, for example, news of a great herd of zebra, of a big tusker, of a couple of lions, or of a solitary (and "ugly") rhinoceros. They may act as guides, beaters, gun-bearers, and makers of pitfall traps.

After the animals have been captured, there still remains to be done work of the most "ticklish" sort, especially in taking the beasts "down to the coast." Crates have to be made and transport arranged—a perplexing matter in a region where the dreaded tsetse fly, perhaps, has wiped out all draught animals, or the mysterious "sleeping sickness" has decimated the natives.



Newly Captured Tusker Secured Fore and Aft.

A Lion-Tamer in Abyssinia

Perhaps the largest caravan of adult lions that ever zig-zagged down to the sea, was that brought from Addis-Abeba, the quaint, "movable" capital of the Ethiopian Emperor Menelik, to Zeila on the Red Sea, by Julius Seeth, the lion-tamer. A curious story attaches to this caravan of truly "forest-bred" adult lions that went jolting down to the coast on a long string of screaming, reluctant, and terrified camels.

Seeth was performing as a "tamer" in Zurich, Switzerland. He owned a couple of ordinary menagerie lions. One day, among his audience, chanced to be Monsieur Ilg, a Swiss adventurer who has become confidential adviser to the "Lion of Judah," as Menelik styles himself, and who occupies at the Court of Abyssinia much the same peculiar position that Kaid Sir Harry Maclean holds under the Moorish Sultan.

M. Ilg, on his return to Abyssinia, chanced to tell Menelik of Seeth's performance, but the Emperor would not believe the story. "My people run," said he, "when a lion roars; yet you tell me this white man actually enters a den of lions? Bring him here, and I promise him his fill of lions."

The result of this challenge was that the enterprising Seeth set out for Addis-Abeba. He waited some time at Aden and Zeila for the permit without which no one may enter Abyssinia, and finally found that Menelik had had no less than thirty-two superb lions caught in pits for him.

These he "tamed" in the usual way; that is, he entered their den with a heavy whip, drove them snarling here and

there, and finally forced them to perform certain stock tricks—forming pyramids, jumping, and the like. The man was well paid for his trouble, and received, besides, the entire collection of lions, which, as we shall see, brought him a fortune.

He had crates made; and his lions were carried in pairs, one on each side of a camel, down to the sea at Zeila. He lost only six or seven by death on the road; and when he returned to Europe he was enabled to give so sensational an exhibit with his four and twenty magnificent lions that he was able to command a salary of $3,000 a week in London, Paris, and Berlin.

Mother and Baby Just Received.

Prices of Animals

A good Nubian lion is worth $1,000; a Senegal specimen, little more than half this sum. A fine tiger is also worth about $1,000. In Bengal, where the most beautiful and largest tigers are trapped, there is a government bounty paid on each, for the annual mortality in India through tigers and snakes—chiefly cobras—is something appalling. The long-haired Chinese and Siberian tigers bring as much as $1,300; and other very valuable varieties come from Persia, and Russian Turkestan.

The dealers are, of course, in constant touch with explorers, missionaries, government administrators, and others in Africa, Asia, the Dutch Indies, and other regions. When, for example, the Russian explorer, Prjevalsky, announced in scientific circles some years ago that he had discovered in the Central Asian deserts of Sungara a new variety of wild horse, the Hagenbeck people resolved to procure some specimens, regardless of expense. But, of course, an expedition of such magnitude was hardly likely to be undertaken without at least a few definite commissions. These were secured from the wealthy Zoölogical Society of London and from several private scientists of rank and wealth like the Duke of Bedford.

In due time the Hagenbeck expedition, having crossed European Russia and Siberia, emerged on the northern border of the great Gobi desert, and made for a village of the Khirgiz horsemen — those strange nomads who correspond exactly to the desert Bedouin of Arabia and dwell in tents of camel-hair. As many as 2,000 of these semi-savage gypsies were hired as guides and "rounders-up;" and then, with a herd of tame brood mares in foal, the entire animal-hunting army set off through the dreary desert in search of the wild horses.

The adventures of the expedition would fill a book. They succeeded in capturing fifty or sixty young colts of this "new-to-science" wild horse; and the youngest of these were cared for by the mares taken with the party. Some idea of the distance traversed in these lonely Central Asian wilds may be realized from the fact that it was three months before the expedition, turning homeward, reached even the nearest station on the Trans-Siberian Railroad. But when, after infinite care and surmountal of difficulties, these strange new horses were landed safe and well in Hamburg, Carl Hagenbeck called his own price. For

some of the finer animals, he received as much as $2,700 each.

Protective Game Laws

One is not surprised to hear that wild animals are growing scarcer. The extinction of the giraffe, the doom of the elephant and the rhinoceros—these seem within measurable range. For years the slaughter of African elephants for their ivory was something appalling. Mr. Selous, in certain seasons in the Kilima jungle, formed of massive tree-trunks with a wide-stretching V-shaped mouth. Once within the walls, their exit is barred by a contrivance known as the "Sanderson drop-gate," so named after its inventor, a distinguished British official of the Indian Civil Service. The excited captives are then visited by a troop of tame elephants of wondrous intelligence, most of them tuskers. Each wild specimen is roped between two tame ones; and if he does not behave himself, his

A TROUPE OF GIRAFFES, THE MOST DELICATE OF ALL ANIMALS.
These strange creatures are extremely difficult to capture and bring into civilization. Notice how awkward it is for the animal to pick something off the ground.

'Njaro region, has owned up to 200 tuskers a month!

The European powers, however, especially Great Britain, have now made stringent game laws protecting the larger wild beasts; and any sportsman wishing to shoot a rhinoceros, elephant, koodoo, or giraffe must take out a license costing, in some cases, $120 for each beast. Of course lions, leopards, and other large carnivora generally, are excepted. In India, indeed, the Government pays a bounty for each tiger killed. There, too, the wild elephants are government property, and their capture the work of a government department.

These huge creatures are enticed into a vast "kheddah" or enclosure in the formidably armed guardians give him a terrible time.

It rarely takes more than two or three weeks for the wild elephant to become tame; and he is then employed as an independent laborer on water-tank construction, road-making, and, in Burmah, stacking teak logs in the great saw-mills of Moulmein and Rangoon. He is a profitable laborer. His life is long, his strength and endurance enormous, while his maintenance in forest regions costs nothing at all. Unfortunately, however, the temper of the elephant is uncertain, and at times he will "strike" work and take to the woods, killing and destroying human beings and property in his path. Every official from the Himalayas to

HALF LION AND HALF-TIGER.
Two Hercules, the only successful grown-up hybrids of their kind ever raised.

Colombo knows what a "rogue" elephant is. One case is on record, in which a country 300 square miles was terrorized and devastated by a "rogue" tusker. This creature seemed to bear a charmed life. Hundreds of bullets were fired into him by soldiers, civilians, and natives, yet he seemed none the worse. He would lie up in the jungle by day, coming forth at night, screaming and trumpeting, to destroy whole villages, wrecking the houses and killing such inhabitants as he could overtake, by snatching them up with his trunk and hurling them against trees. The Lieutenant-Governor of the Bombay Presidency was finally obliged to send out soldiers and artillery, whereupon the big "rogue" was slain. His skull, wonderfully riddled with holes and bearing an inscribed brass plate with his lurid record, may now be seen in the Natural History Museum at South Kensington, London.

HERR SIN, UP LARGE LION-TIGERS BY HAND.

But while the Indian elephant is always available, his African brother is extremely scarce in the market. Only about five have been imported into Europe since 1880. A good African tusker will fetch up to $2,500, whereas an Indian elephant may be worth only half this sum.

Other Big Game

Giraffes are rarest of all. At one time the London Zoo had a standing offer of $5,000 for a good adult bull. Not only are they scarce in Africa, but the work of transporting them over-sea is the despair of every wild-beast importer. And even when, after infinite solicitude and care, they are landed safely in New York, Hamburg, or London, they are apt to die like a flower, so delicate are these most curious of creatures.

Zebras are more than plentiful; and to this day the Athi Plains of Somaliland are fairly alive with them. Interesting experiments have recently been made by crossing them with horses, and obtaining a new kind of mule for hard work.

Naturally, a man like Carl Hagenbeck could write a book of exciting adventures

vhich would transcend any boy's story hat fiction writer ever turned out. His ght with a huge Indian leopard that got oose on board ship and turned on its ursuers in the dark recesses of the tokehold; his miraculous escape from n enraged bull tusker who did not want o be sent away and so drove his great usks with five-ton momentum at his naster—only to find his victim's body afe between those tusks—these are but ncidents in this great dealer's life.

Asked what rates of insurance are uoted him on his living freight during its transit through jungle and desert and sea, Mr. Hagenbeck replied, "I do not insure at all. I find it pays me better to take the risk myself."

Performing Animals

A most lucrative branch of traffic in wild beasts is the sale of performing animals. At Stellingen there are regular "schools" or "academies" wherein wild animals are educated, whether they be boxing kangaroos, wrestling lions, elephants that are their own chauffeurs in motor cars, polar bears that drink toasts at festive parties, tigers that draw chariots as though for jovial Bacchus himself, or seals that juggle with fiery brands. Hither come the great circus companies' buying agents in search of novelties; and such is public appreciation that a new feat, a clever idea in training, may actually double a wild beast's value in the market.

Cross-Breeding and Acclimatization

Mr. Hagenbeck has even essayed to produce entirely new animals, for which purpose he is always cross-breeding, as though growing orchids instead of dealing in wild beasts. Among the products of his experiments are huge felines that are neither lions nor tigers, but both, with the one brute for father and the other for mother; also "zebrules"—another new cross between horse and zebra. Moreover, having for many years, in common with other great importers, lost heavily through deaths due to climatic causes, he is now—and with marked success—trying to "harden" both birds and beasts by compelling them to winter in the open air.

BEGINNING THE EDUCATION OF NEW ARRIVALS.
Posing the lions and tigers.

The inception of this huge business was curious. The elder Hagenbeck was a fisherman sixty years ago, and the nucleus of the present world-embracing enterprise was six poor little seals which Hagenbeck *père* picked up on his travels!

Bartels Establishment in New York

On a much smaller scale are the transactions of Mr. William Bartels of New York, who has a big animal park out on the meadows of New Jersey. He sells many lion, tiger, and bear cubs to wealthy families as children's playmates; but one is not surprised to hear that a few months later he is sent for to take away at any price the now huge and dangerous pets that affright the neighborhood.

Mr. Bartels sends out his own wild-beast catchers to various strategic points in Africa and Asia. He also has over twenty men at work for him in South America, besides camel-hunters in Southern Siberia and his tiger-trappers in Bengal. Mr. Bartels, however, has a low opinion of the methods employed by native trappers to secure adult specimens. They dig a pit, cover it with matting, and then tether a live goat or sheep in such a way that the lion or tiger or leopard, springing for its prey, must fall into the pit. Frequently this pit bristles with stakes of iron or hardwood, so that if the brute is not killed outright, he is at least maimed and injured and may die whilst they are hauling him out with nets and nooses. Mr. Bartels catches huge pythons in Sumatra and Java simply by gorging them with dead

HOW CRATES AND CAGES FULL OF WILD BEASTS ARE LANDED FROM BARGES AND LIGHTERS WHICH HAVE JUST LEFT THE SHIP'S SIDE.

Getting ready to hoist them onto the dock.

meat and then bundling them into blankets inside a crate or case. The death losses attending the transportation of the animals from their native habitat to New York, is fully twenty per cent. Sometimes an entire liner or tramp steamer is chartered for the transport of a big consignment. Nothing must interfere with the care and attention lavished on the creatures during the voyage. If a python's well-being call for another live goat, he must have one. Live cows are carried for milk for the monkeys and "babies" generally. And there are live rabbits and rats for the snakes; horse flesh by the ton for the *felidæ,* and bales of green food for the elephants, besides medicines and delicacies. Much, very much, depends upon care in all details during the voyage. Tens of thousands of dollars worth of property in wild beasts may be saved in this way.

In storms, frequently, dangerous animals get loose, and men perform deeds of daring with no thought of the newspaper paragraph. Just think how a man must feel who passes down the gleaming, roaring aisle of crazy cages on a stormy night, and finds that a fifteen-foot Bengal tiger is missing! Where is he? Will he spring and kill from some dark corner? And anyhow, how is he to be got back into another cage with the ship heaving, rolling, and pitching in a heavy sea? Nor is the "vet" to be envied. An elephant with toothache (diseased tusk) is a mighty perilous patient for any dentist. A fifteen-foot alligator with ulcerated gums is also a problem calling for blindfolding, ropes, levers, and much vigor, besides professional insight. There are also lions to be dosed for colds, and operated on for ingrowing claws. Chloroform is given these by means of a saturated sponge. Monkeys suffer from almost every ailment known to man, including consumption; and if bandages be put on them, their mischievous hands must in some way be kept from undoing the surgeon's good work out of sheer curiosity and folly.

It is not surprising that three men practically monopolize the wild-beast traffic of the world. But these make money. When Mr. W. Simpson Cross, now head of the firm of Cross of Liverpool, secured a pygmy elephant three feet high and weighing but 120 pounds, he was fairly besieged with telegrams, "Have bought baby elephant at your own price. Wire acceptance."

The Cross establishment being in the heart of a city with over a million inhabitants, has had more than its share of exciting episodes. At one time the premises caught fire. Mr. Cross did not dare to liberate the lions and tigers when it was found to be impossible to get them out otherwise. He lost $80,000 worth of wild animals, birds, and reptiles in that fire. The elephants were led out, frantic with terror, and one of them assaulted a street-car, with no thought of subsequent action for damages!

It is strange how careless these great animal dealers become in handling wild beasts and deadly reptiles. They look upon their rhinos and lions, tigers and bears and cobras and crocodiles, much as the stockman regards his flocks and herds—no more, no less. It is told of Jamrach, formerly a well-known dealer of London, that on going down to his establishment one morning, he burst out wrathfully to his lion-keeper, "I'm beset at home as well as in the dens. Here's my wife actually saying that she won't allow the boa constrictors any longer to sleep under our bed even in the coldest weather!"

High Aim

BE noble, and the nobleness that lies
In others, sleeping still but never dead,
Will rise in majesty to meet thine own.

Bridge-Building in the Jungle

Great Cantilever over the Gorge of the Once Mysterious Victoria Falls, Now a Link in the Cape-to-Cairo Railway Route

By GEORGE R. METCALFE, M. E.

Formerly Technical Editor, Scientific American Supplement

AN engineering feat of considerable magnitude has recently been accomplished in the erection of a large cantilever bridge over the Zambesi river near the great Victoria Falls in Africa. This bridge forms a part of the permanent way of the Cape-to-Cairo Railway, which is to connect Egypt with South Africa. At the point where the bridge crosses the Zambesi river, is a gorge 420 feet high, and the bridge crosses the top of the gorge almost on a level with the top of the Victoria Falls.

Communication between the two banks of the gorge was first established by means of a line rocket fired from one bank to the other, and by drawing over ropes of gradually increasing sizes. The two sides were eventually connected by means of a cable 2.7 inches thick; and upon this a Blondin transporter was operated. This transporter was able to carry a load of ten tons; and within a few weeks, over 1,000 tons of material for the bridge and the roadway, as well as locomotives and trucks, in pieces, were conveyed across the gorge.

CENTRAL SPAN OF GREAT BRIDGE OVER GORGE NEAR VICTORIA FALLS, RIVER ZAMBESI, RHODESIA.

The bridge, owing to its location, had to be erected on the cantilever principle, each side being made self-supporting, and the two sides gradually approached each other until they were finally connected at the center. The total length of the bridge is 650 feet, of which the central span includes 500 feet. This central span is made of 20 bays, each 25 feet long. It will be seen from this that, during its erection, there was an overhang on each side of 250 feet before the

VICTORIA FALLS, RIVER ZAMBESI, FROM NORTH BANK AND NEAR THE GREAT BRIDGE.

bridge could be connected together; and, owing to its location over a deep gorge, there was no possibility of using staging, scaffolding, or other similar aids in its erection. To counteract this weight of several hundred tons on the overhanging ends, a cable was made fast to each of the unfinished sections, and was carried upward to the shore ends, where it was anchored to the bank. All the riveting, lighting, and transporting were done by electricity.

During a considerable portion of the year, the bridge is surrounded by a cloud of mist from the falls, and this makes its protection from rust a problem of great importance. During the erection of the bridge every piece was carefully inspected, all signs of rust were removed, and a special coating of waterproof paint was used. The finishing coat of the bridge will be of a dull gray enamel, this shade being selected so as to allow any signs of rust to show prominently.

GENERAL VIEW OF THE VICTORIA FALLS BRIDGE.

Wonder Cities of Electricity

Soot, Dust, Smoke, Dirt, Noise, and Confusion Banished by the Establishment of Great Central Power Stations

By S. MORGAN BUSHNELL

Electrical Engineer

THE age in which we live may justly be called the age of mechanical power. In every realm of industry, manual and animal labor have been supplanted more and more, until to-day the main portion of the world's work is performed by machinery. For this reason the economical production and distribution of power is the greatest problem of the age.

Until within a few years, power has for the most part, been produced in comparatively small amounts. If one will take a bird's-eye view of any of our large manufacturing cities, he will see a landscape studded with great chimneys, iron stacks, or tile smoke-flues, each of them, at successive portions of the day, pouring forth dark volumes of pulverized carbon. These stacks and smoke-flues connect with boilers which supply steam for small power plants located throughout the business and manufacturing districts of the city. Such, to a large extent, are the conditions of municipal power production as we find them to-day; but these conditions, in all probability, will be largely modified in the near future.

Evoluton of the Central Station

During the past ten years, a great change has commenced in the methods of producing power, due to new methods in the generation and transmission of power by means of electricity. Developments along this line have been extremely rapid. At the time of the invention of the Edison three-wire system, and the starting of the various Edison stations in the large cities of the United States about twenty or twenty-five years ago, it was claimed that this new system would enable central stations to transmit electric power and lighting economically over a radius of one mile. This seemed to some to be an extravagant assertion; but it was only a few years before it was demonstrated to be a practical and successful proposition.

The use of alternating currents at high potentials, enables the central station to-day to exceed by far the one-mile limit; and power is being transmitted from the large stations to distances which would scarcely have been dreamed of twenty years ago.

The old idea of a central station was a power house located near the center of a distributing system—necessarily located near the center in order to secure an economical transmission of current to the various consumers. To-day, large power stations are being constructed, which, instead of being located near the center of the district to be supplied, are installed miles away, either at some waterfall or at some point where coal can be easily secured and where ample water supply for condensing purposes will be constantly on hand.

The size of generating units has had a growth equally rapid. Twenty years ago, the 100-kilowatt dynamo, manufactured by the Edison Works at Schenectady, New York, was the largest electric generator produced. At the time of the World's Fair in Chicago in 1893, the 1,000-horse-power "Jumbo" generating unit exhibited by the General Electric Company was considered an experiment. To-day the large central stations are prepared to install direct-connected steam turbine generating units having a maximum capacity of 15,000 horse-power on a two-hour basis.

Water-Power Development

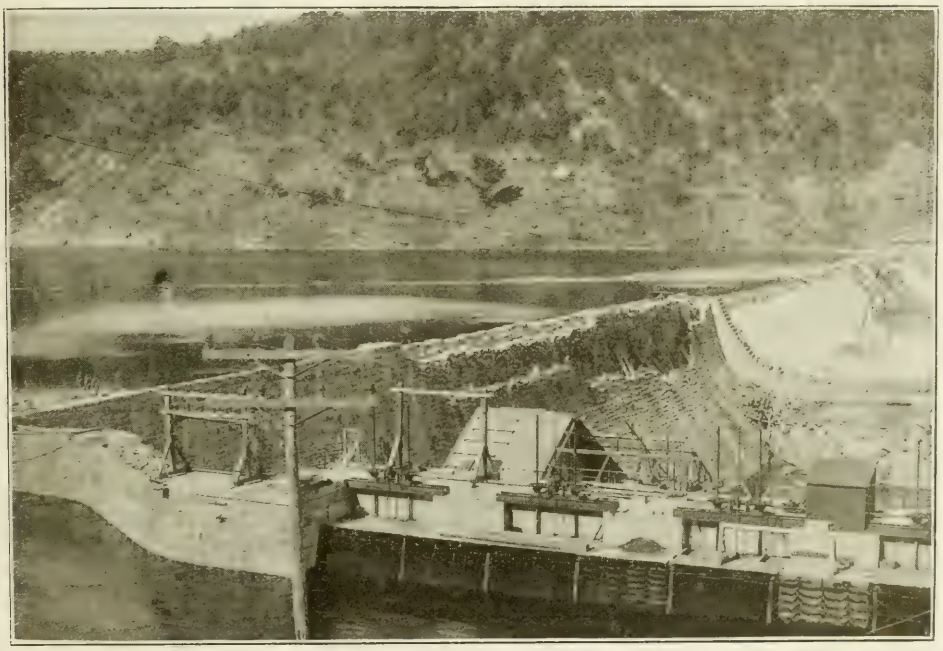
In this transition from the period of small power-producing units to that of the great power stations, perhaps the most notable factor has been the rapid development of power supplied from the

rivers and waterfalls at various points throughout the country. In order to realize the great change that has taken place, let us note a few instances.

The city of Montreal, in Canada, is supplied with power for lighting by twelve 750-kilowatt three-phase dynamos located at the Lachine Rapids Water-Power Plant more than five miles away. This power, when reduced to 16-candle-power lamp equivalent, gives an aggregate capacity of over 175,000 lights. A still later development is the transmission of 20,000 horse-power to the same city from the Shawinigan falls. Here a 100,000-horse-power plant has been constructed so as to utilize the power produced by the St. Maurice river through a drop of 140 feet. These falls are located 85 miles from Montreal, and the power is transmitted over a pole line at a pressure of 44,000 volts.

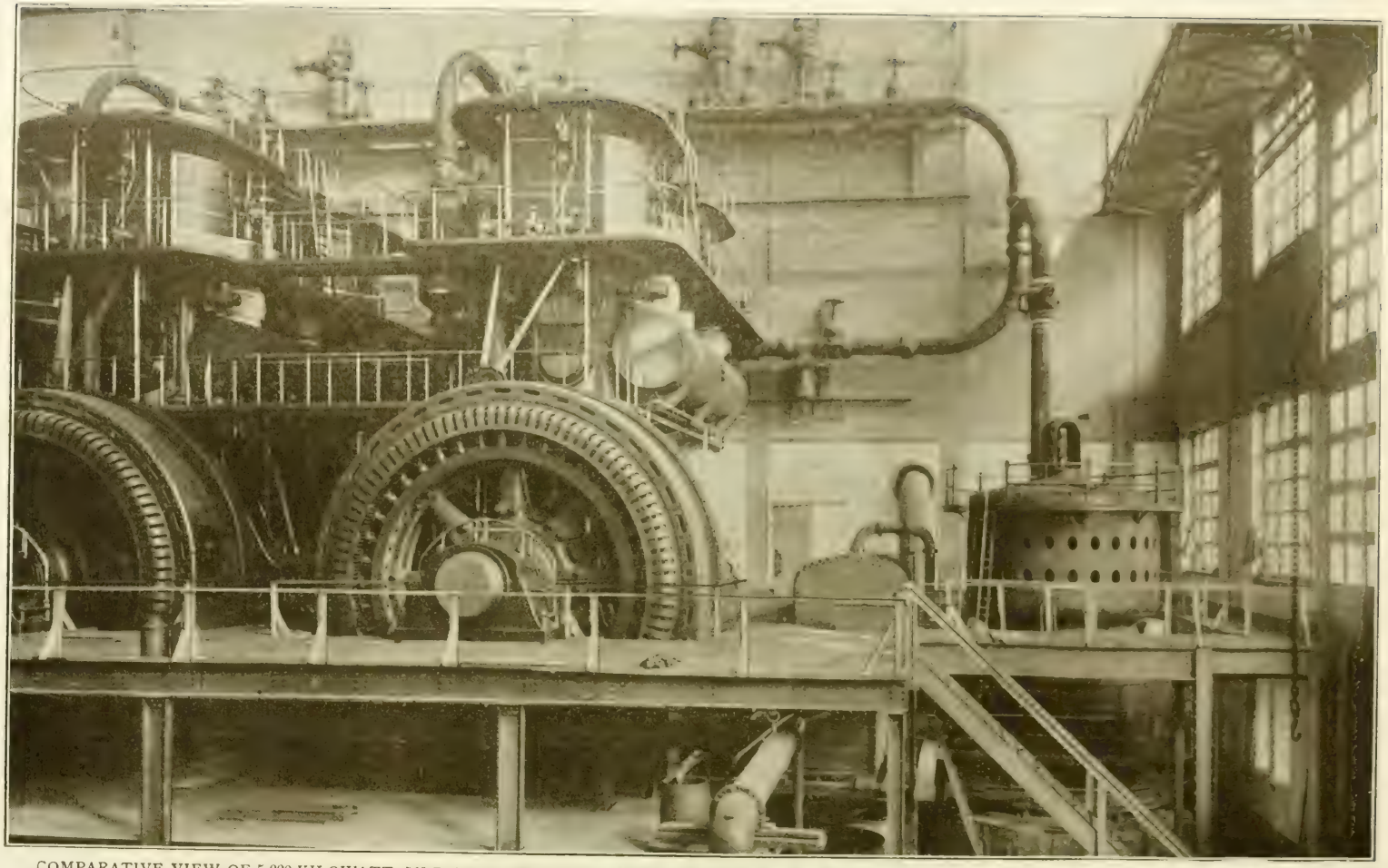
The world has recently had its attention drawn to the wonderful developments of the lead and zinc mines of Joplin, Missouri. During the past few weeks a new plant has been started; and the power to operate these mines will be supplied from the Hydraulic Electric Power Transmission Plant of the Spring River Power Company.

California, for a number of years, has been noted on account of its various power transmission plants, in which the power of the melting snows on the mountain tops 50, 75, and 100 miles away is transformed into electric energy in the cities of Sacramento, San Francisco, Santa Anna, and Los Angeles. A similar development may be seen in the State of Washington, where glacier-born streams of Mount Tacoma (Rainier) now supply power that lights the streets and runs the street-cars in the cities of Tacoma and Seattle.



CANAL AND DAM AT SPIER FALLS, NEW YORK.
One of the principal power stations of the Hudson River Power Company.—View taken October 5, 1904.

The great works of the General Electric Company at Schenectady, employing more than 12,000 operatives, are largely run by power supplied from the Spier Falls and Mechanicsville power houses of the Hudson River Water Power Company. The new plant at Spier Falls, which has hardly been in operation for two years, has a capacity of about 30,000 horse-power, and is operated in connection with a number of other water-power plants in that vicinity, owned or controlled by the Hudson River Water



COMPARATIVE VIEW OF 5,000-KILOWATT, 500-R. P. M., 6,600-VOLT CURTIS STEAM TURBINE WITH GENERATOR, AND 3,500-KILOWATT GENERATOR COUPLED TO VERTICAL COMPOUND ENGINE.

View in Waterside Station of The New York Edison Company, New York City.

Power Company. These power plants not only provide power for the great factories at Schenectady, but also furnish light and power for the city of Albany, the city of Troy, and other towns in that vicinity.

Turning southward, we see the old City of Mexico, commonly regarded as the city of an old and effete civilization, governed by the ancient customs of the Aztecs and their former rulers, the Montezumas. But even here we find a city which is rapidly advancing by the utilization of electrical power. The electric lights, street railways, and various manufacturing plants, are about to be connected to electric power transmitted from the Necaxa Hydraulic & Electric Power Transmission Plant located at the falls of the Necaxa, 100 miles away. At these falls, situated far up in the mountains, there are two plants, which, when completed, will have a combined capacity of over 80,000 horse-power. Three transmission lines of 20,000 horse-power each, are already run to the City of Mexico; and from Mexico onward to the mines of Del Oro, another line carries the power 71 miles further. In other words, the power used to operate the rich gold and silver mines of Del Oro is generated 171 miles away, at the Necaxa falls. This power is transmitted at a pressure of 60,000 volts; and we are told that the loss in the transmission line at full load is only 8 per cent at the City of Mexico, and 5 per cent additional at the mines.

Niagara's Unrivaled Power

But perhaps the most notable and interesting of all our great sources of hydraulic energy is the Falls of Niagara. Here we have the ideal conditions for a great water power, as we have not only a large and steady supply of water, but also a sudden fall, which means the location of millions of horse-power within the short radius of one mile. In order to give a little idea of the power produced at this point, let us enumerate the plants which are now installed or in process of construction, on both the American and Canadian banks of the river.

The Niagara Falls Power Company has two plants located on the American side just above the falls. Power plant No. 1 has ten 5,000-horse-power units, while power plant No. 2 has eleven 5,500-horse-power units. The Niagara Falls Hydraulic Power & Manufacturing Company has a power plant located on the American side just below the falls, having a present capacity of about 40,000 horse-power. This company is at present building a new plant adjacent to the old one, which will have an additional capacity of 100,000 horse-power, making the total capacity of this company 140,000 horse-power.

On the Canadian side, the Niagara Falls Company are installing eleven additional units of 10,000 horse-power each.

The Ontario Power Company has a plant located just below Table Rock on the Canadian side, in which they have already installed four 10,000-horse-power units; and the plans of their plant provide for a maximum capacity of 220,000 horse-power. The Ontario Power Company are producing electricity at a pressure of 12,000 volts; and this voltage is raised by step-up transformers to 60,000 volts, at which pressure the electric energy will be transmitted to Rochester, Syracuse, and other towns along the line of the New York Central Railroad. It is said that the system of trolley lines running from Buffalo to Albany will soon be operated by electricity produced by water power, the western half to be supplied with current from the Ontario Power Company, while the eastern half will receive its supply from the plants already mentioned of the Hudson River Water Power Company.

The Niagara & Toronto Company are building another power station on the Canadian side, which is to have a maximum capacity of 125,000 horse-power; and this company expects to suppy electricity to the city of Toronto. The combined capacity of these plants, when completed, will amount to an aggregate of over 700,000 horse-power, all produced within a radius of one mile.

Chicago a Future Electrical City

In order to realize what this means and the bearing which it has on the electric city of the future, let us make a comparison with the total power produced in some great city. Let us take for example the city of Chicago, which is preeminently a manufacturing city, and

which requires power, not only for its large operations at the Stock Yards and for its great manufacturing enterprises like the International Harvester Company and the Illinois Steel Company, but also for its extensive systems of local transportation, which require immense steam power-producing plants. A careful examination of the Stationary Engineer's Directory of Illinois issued for the year 1905, shows that the total engine horse-power in Chicago, exclusive of the Traction Companies and the Central Power Stations of the Edison and Commonwealth Companies, amounts to nearly 450,000. The Traction Companies have an installed engine horse-power of a little more than 120,000 additional, while the Edison and Commonwealth Companies have more than 80,000 horse-power. Adding these items together, we have a grand total of about 650,000 horse-power in engines installed in the city of Chicago, these engines being operated from high-pressure steam boilers.

When we remember that this 650,000 horse-power is largely composed of comparatively small units, we can readily see that a single plant of 500,000 horse-power would be ample to supply all the power required for the electric lighting, traction systems, and factories of the city of Chicago. If the above estimate of 500,000 horse-power is correct, then the present plants of Niagara Falls, when completed, will have a capacity equal to the entire power requirements of Chicago with about 200,000 horse-power to spare.

Let us extend this illustration a step further. The city of Chicago has a population, in round numbers, of 2,000,000; while the population of the entire country, in round numbers, is 80,000,000. Assuming that the proportion of manufacturing to population were the same throughout the country as it is in Chicago, we should have in Chicago about one-fortieth of the mechanical power production of the United States.

We all know, however, that a great portion of the people do not live in great manufacuring cities, but live in the country, and are engaged in farming, stock raising, and similar pursuits. It is safe to say, therefore, that the power used in Chicago will form a considerable fraction of the entire power produced in this country.

Expert hydraulic engineers tell us that when the present plants at Niagara Falls are completed, and the full 700,000 horse-power is being produced, it will require but a small fraction of the water now constantly discharging itself over the falls, and there is no danger that the present plants will in any wise interfere with the beauty and grandeur of this great cataract. It is, therefore, not improbable that we have in the Falls of Niagara sufficient power to drive every workshop and every mill from Sandy Hook to the Golden Gate, and from the Red River of the North to the rolling waters of the Gulf.

Beauty Not Sacrificed

The power houses now built or in process of construction at the Falls, are long, low buildings of ornamental stone; and where it is practicable, they are surrounded with green lawns so as to form an attractive picture. The entrance to the new power house of the Niagara Falls Power Company would be entirely suitable for an art museum, the floors of beautiful mosaic tile, the stairs and walls of pure marble, and the soft glow of incandescent lamps giving to the beholder the impression that he is in the doorway of some fairy palace rather than at the entrance to a huge power station.

Long-Distance Transmission

In the August (1905) number of *The Electrical Age,* Mr. Alton D. Adams gave some very interesting figures showing the practicability of transmitting power from Niagara Falls to New York City, and of selling the energy thus transmitted at rates lower than the present prices for electricity in that metropolis. If this power could be economically transmitted to New York, it would be but a step farther to transmit power from the same source to Chicago. But Chicago need not depend on Niagara power. To-day there are two outlets from the Great Lakes—one by way of the Niagara river and the St. Lawrence to the Atlantic Ocean; the other by way of the great Drainage Canal of Chicago and the Illinois and Mississippi

rivers to the Gulf of Mexico. The Drainage Canal Commission is now engaged in the work of broadening and deepening the Chicago river so as to give it a minimum width of 200 feet and a depth of 26 feet. The waters of this river do not flow into the waters of Lake Michigan, but into the Illinois river, and thence southward to the Mississippi. This great canal, which was constructed to provide a drainage system for the city of Chicago, has also considerable possibilities in the way of hydraulic power. Already contracts have been let for four 4,000-kilowatt electric generators to utilize the Drainage Canal water power at Lockport, Ill. The deepening and widening of the Chicago river is expected to increase the capacity at this point to 30,000 horse-power; and if the Calumet-Sag canal should add its waters to the Drainage Canal, there would be an ultimate capacity of from 40,000 to 50,000 horse-power.

NECAXA FALLS, LOCATED 100 MILES FROM THE CITY OF MEXICO.

But Chicago will not need to depend on hydraulic power. We have already called attention to the fact that in the main generating plants of the Central Station Companies there is a capacity of more

UNRIVALED NIAGARA.

than 80,000 horse-power already installed. A year hence, this 80,000 horse-power will have been swelled by the addition of 60,000 horse-power at the great Fisk Street Station of the Commonwealth Electric Company. Assuming that the present maximum horse-power required by the city of Chicago is 500,000, there would then be about one-quarter of the power required for the city, located in central stations.

In the annual report of the Department of Electricity for the city of Chicago, issued December 31, 1904, out of a total of incandescent 16-candle-power lamp equivalents of 2,068,159, there are 1,298,321 reported as connected to the central stations. On this basis it is fair to assume that nearly 65 per cent of the incandescent electric lighting in the city of Chicago is already supplied by the central stations. Furthermore, it will be found by comparing the reports of former years, that this proportion is constantly increasing in favor of the central station service.

Location of Generating Station

The question is sometimes asked, Why do not the great Central Station Companies, which depend on steam generating plants for their power, locate these plants at the mines where coal can be procured at a minimum of cost, and then transmit the electricity at high voltages to the cities and towns? The answer to this lies in the fact that the cost of coal is only a small fraction of the total cost of producing electric power; and, furthermore, the cost of transporting the coal where the distance is only 100 or 200 miles is only a fraction of the total cost of mining and delivering the coal.

On the other hand, the supplies for a great central station can be more easily secured at or near the city; and the cost of transformers and expensive pole-line construction is so great that it will largely offset any saving in the cost of coal. The net saving, therefore, would be so small that it would not enable the central station to make enough difference in its rates to have any appreciable effect on the volume of business. For example, where current is sold at 10 cents a kilowatt-hour, a saving in cost of 1-10 of a cent per kilowatt-hour would enable the central station to make a reduction of only 1 per cent in price.

But the main point of disadvantage in locating a plant near the mines would be a decreased reliability in the service, especially in the larger cities. In cities like New York, Chicago, and Boston, the conductors for supplying current to consumers are run underground, and consequently there is less chance for interference in the service than there is in the case of pole lines, which not only are exposed to danger from lightning and storms, but are more likely to be interfered with in other ways. It is the absolute reliability of central station service which appeals most strongly to the current consumer in a large city; and in comparison with this, a difference of 1 per cent or even 2 per cent in the price of the current would hardly be considered.

Furthermore, the modern central station is well equipped in its arrangements for coal supply. Coal is shipped direct from the mines, in hopper-bottomed cars, to the tracks leading alongside the central station. At this point it is dumped into hoppers which lie directly below the track; and from these hoppers it runs into buckets on a traveling conveyor which carries the coal up to the top of the building. At the top of the building, these buckets are tripped at various points by a tripping device, which can be located wherever it is desired to unload coal. In this way the coal is loaded into great hoppers often having a capacity of more than 100 tons each. From these hoppers the coal is fed down to the front of the boilers into movable chain grates, which act as automatic stokers and supply the coal automatically to the boilers.

From the above it may be seen that the amount of labor expended in delivering the coal to the boilers after it leaves the mines, is reduced to a minimum, and that the cost per unit of power must be correspondingly reduced. So thoroughly have the methods of handling coal and utilizing steam by the most efficient processes, been developed, that some of the large steam power-generating stations of to-day can produce power as cheaply as some hydraulic power stations, especially

where the water-power station has been compelled to make immense investments in dams, sluiceways, and other controlling apparatus, thereby entailing a high proportion of fixed charges. The only way in which the hydraulic power station can become profitable, is by producing power on a large scale; and, in like manner, the main requisite for a profitable steam power-generating station is the production and sale of power on a large scale.

ENTRANCE TO POWER STATION NO. 2 OF THE NIAGARA FALLS POWER COMPANY.

Function of the Turbine

Perhaps no other one thing has contributed more to the economical production of power in the steam-generating plant than the invention and development of the modern steam turbine. The use of the steam turbine secures high speed in large units, with a maximum efficiency. This not only reduces the size of the turbine, but also the size of the electric generator; and this in turn reduces very greatly the cost as compared with the slow-speed engine and direct-connected dynamo. A large element in the cost of power from the electric power station is the fixed annual charge on account of the initial investment. The new steam turbine generating units secure the production of large quantities of power with a moderate initial investment per unit of power, thereby putting the central station in a position to compete successfully with the isolated steam plant whether it be located in an office building, a store, a hotel, or a manufacturing establishment.

Abolition of Annoyances

As one by one we see the old steam plants in our large buildings discarded, we begin to approach the realization of the ideal electric city. The tourist when stopping in the city of Niagara Falls, notwithstanding the immense manufacturing industries which have grown up there within the last few years, will see almost no chimneys delivering their smoky contribution to the otherwise clear atmosphere. Here, every steam plant has been shut down, with the exception of one or two small plants in which it is necessary to use steam in the treatment of wood pulp for the manufacture of paper. In

these mills the power processes are performed either by the direct agency of water power or by electric power through the agency of motors.

The visitor to some of the model factories recently built, will wonder how it has become possible to preserve the absolute cleanliness that is found on every floor and in every department. He will find that small electric motors have displaced the old systems of shafting and belts, with their connections from floor to floor, their rasping noise and vibration, and their accompanying dust and dirt. The result is the ideal workshop. Electricity gives the most perfect lighting, the most perfect source of power, and the most easily manipulated form of heating, whether in the factory, the office, or the home.

A great deal has been said in regard to the smoke nuisance in our large cities. To-day that problem is disappearing, as one by one the large stores and apartment houses, which formerly took their turn in contributing to the murky pall hanging over the city, have successively thrown out their independent plants and selected their power from the great central station source of supply.

If we look forward, we shall see the city of the future, with its beautiful parks and boulevards, its great manufacturing enterprises, and its magnificent stores and hotels, all illuminated and operated by the one form of force which has been found to be applicable to every human industry and every energy-requiring process. That city will be the Electric City; and the power, whether from a great hydraulic station or from a vast steam generating plant, will be centralized so that the work of producing the energy consumed may be carried out on a large scale and hence on the most economical basis.

Dancing Carnival at Binche

The Quaint Custom of a Little, Old Belgian Town

By WILLIAM G. FRASER

THE prosperous little country of Belgium abounds in most peculiar manners and customs and strange Old-World ceremonies, many of them purely pagan survivals. For example there is the Whit-Tuesday dancing procession at Echternach, when one sees an entire countryside—men, women, and children, not to mention priests in full vestments—gravely dancing with a hop, skip, and a jump through the Old-World streets of that Luxembourg town.

It is well known, too, that the Flemish and Walloon peasants are very tenacious of their ancient customs; and of these perhaps the quaintest is the procession of Dancing "Gilles," which takes place on Shrove Tuesday in the picturesque little town of Binche, in the province of Hainault.

These "gilles," or dancing men, who form so peculiar a feature of the Binche carnival, are famous for their extraordinary head-dress—a kind of silk hat, such as was worn by our grandfathers, surmounted by magnificent ostrich plumes three or four feet long. Besides these, each hat is provided with long, streaming ribbons; while the "gille's" trousers are incongruously decked with exquisite Mechlin lace and ribbons to match those streaming from his hat.

Each "gille" also wears a grotesque mask and a silken belt hung with many silver bells. His entire outfit may cost $50—a small fortune to one of these peasants. The "gilles" are selected with as

much care by the Carnival Committee as though they were actors in the great Passion Play of Ober-Ammergau. In fact, the honor of being chosen a "gille" is so great among the young Lotharios of Binche, and carries such prestige with the maidens of the town, that the young men chosen by the Committee are only too pleased to make the necessary financial sacrifice which the strange mediæval costume demands.

Shrove Tuesday afternoon sees the "gilles" of Binche in all their splendor of feathers, ribbons, masks, and bells—200 of them altogether—parading the streets exactly as their forefathers have done for a thousand years. Before them go the brass bands and musical clubs of

PROCESSION OF DANCING GILLES IN FRONT OF THE TOWN HALL, BINCHE.

the city, leading the way towards the *Grande Place.* The "gilles" invariably dance as they walk; and after every few steps, with one accord they halt, bow down low, and then straighten themselves with a sudden jerk, that the jangling and tinkling of their bells may be heard afar off.

There is great excitement in the little Old-World town as the "gilles" come along with their gay streamers floating this way and that, enveloping them in rainbows of color. The crowd behind thump their wooden sabots on the stones, and crane eager necks to see when the pelting begins. For each "gille" carries a straw basket hanging from one side of his belt and filled with oranges.

With these the dancing men bombard the crowd as they prance forward; and no sooner is an orange basket emptied than it is filled up again by the quaintly clad boy attendant that waits upon each "gille." Villages for many miles around empty themselves into Binche on the great day of the carnival; and every man, woman, and child among them makes for the great square in front of the Town Hall.

Here, seated on a gaily decorated platform, is enthroned the Mayor of the City, surrounded by all his municipal officials. One is amused to note that in this remote and sleepy little Hainault town there is as much stately form observed among municipal officers as there would be at the Imperial Courts of Berlin or St. Petersburg.

The queer-looking dancing men dance more wildly than ever in front of their Mayor; and so contagious is their example that presently the thousands of spectators begin to dance too, so that in a few minutes one sees the extraordinary spectacle of the entire *Grande Place,* black with human beings, dancing for dear life!

Here are elderly ladies weighing more than 250 pounds; there, a serious-eyed man with a couple of infants in his arms. All are dancing—an entire countryside; and if rain comes on, the spectacle is still more bizarre to the foreign spectator at an upper window, who sees ten or fifteen thousand umbrellas capering up and down below him to the wild strains of the Walloon bands.

A Dancing Gille at the Carnival of Binche, and his Boy Attendant.

Only when positive physical exhaustion supervenes does the crowd cease to waltz; and then men, women, and children seek their own homes in the town, or melt away into the fat plains of Hainault to their own remote villages, feeling sure they have done their duty by taking part in the strange pageant, as their forefathers have done before them all down the centuries.

Voting Machines in Use

Paper Ballot Already Done Away With in Hundreds of Cities, Saving Time and Money and Preventing Errors and Fraud

By ISAAC N. POWELL

Chief Clerk, Board of Election Commissioners, Chicago, Ill.

Seventeen of the largest and most important States—including New York, Illinois, Ohio, Iowa, Kansas, and California—have already passed laws legalizing the use of voting machines in all elections. By an act of the Fifty-fifth Congress, their use was legalized for the election of Representatives in Congress. Voting machines are exclusively used in 887 cities and villages in New York alone, and in many municipalities throughout the country.

If faith in the honesty of our elections is to be preserved, some method of voting must be provided which will more nearly eliminate the possibility of error and fraud.

The desire for a change in the method of conducting elections, which is apparently uppermost in every community, was strongly expressed in Chicago, when, at the election of November 8, 1904, the act permitting the use of voting machines was adopted by the unprecedented vote of 229,068 for, to 26,990 against. This extraordinary vote for the proposition was not the result of any agitation in favor of machines, nor was it a protest against the present form of ballot on account of any frauds. It indicates the voters' belief that voting machines represent a system more in keeping with the progress of the times.

Do Not Make Voters Honest

While voting machines afford the greatest safeguard for honesty in elections now available, their field of usefulness in that direction is limited to their accuracy in counting and showing the vote actually cast. They do not insure the honesty of the voter. No method has as yet been provided which will absolutely protect the public from the fraudulent voter. But, it is possible to limit his activities by adopting methods which make his operations difficult and hazardous. The best remedy now at hand seems to be the voting machine.

Frauds and conspiracies, as is well known, are more certain of consummation when the parties interested are reduced to the minimum number. It is the idea of self-preservation that causes most election frauds to be committed after the close of the polls. A few persons can do then what would have required a great number while the polls were open. One man can change the result of one hundred or more ballots honestly cast, with less liability of detection than if one hundred fraudulent voters were hired to cast those ballots. In other words, it is easier to secure one man to change one hundred ballots than to secure one hundred men to cast them; and while the fraud perpetrated is glaringly visible, the culprit is not always easily apprehended. The publicity of results, and their quick announcement, is one of the surest means toward securing the honest counting of votes. The machine not only permits a person to cast his vote, but also then and there counts and adds it for the candidate of his choice. The fact that the announcement of the vote is practically simultaneous with the closing of the polls eliminates the opportunity of manipulating the count for fraudulent purposes, as time in which to perpetrate a fraud is an exceedingly important factor in its execution.

Greatest Frauds after Polls Close

No machine, of course, would be capable of withstanding the dishonesty of those who had to do with its preparation for election day. The same criticism would be applicable to any other method of voting. The fact is, however, that the

greatest election frauds are committed after the closing of the polls; and it is at that time that the machine performs one, if not the best, of all its functions, inasmuch as it furnishes a complete detail of the vote for each candidate and displays it to the gaze of the public in so short a time that conspiracies and collusions are frustrated.

Honest men are essential to the proper execution of any task, and they are not so rare but that at least one can be found to act as watcher in each precinct; and one honest, alert man can foil all the schemes of those daring enough to attempt an outrage against the public franchise. Most voting machines are so constructed as to afford, by means of special mechanism, immediate detection in the event of their being tampered with.

Absolute Accuracy Guaranteed

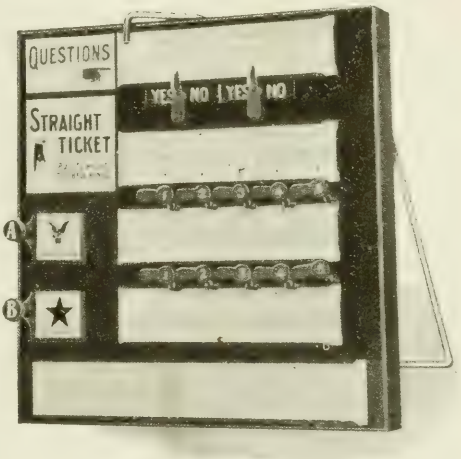
Machines are accurate, and are free from political bias—a virtue the human family lacks. One would not expect them to protect us against our own ignorance and inefficiency; and yet, in fact, they do. The writer has yet to see any machine that would permit a voter to spoil a ballot in any particular. True, the machine will not require a voter to vote for all the candidates for whom he is entitled to vote, but it will prevent him voting for more candidates for an office than the law permits and thereby losing his vote as to that office.

At the election in Chicago held November 7, 1905, four Judges of the Superior Court were to be elected. There were in all on the different tickets sixteen candidates for the office. A voter using the paper ballot, had he voted for more than four of these candidates, would have lost his vote so far as the office of Judge of the Superior Court was concerned. Had this same person voted by the machine, its mechanism would have made it absolutely impossible for him to vote for more than four candidates for the office named.

Small Danger of Breakdown

There is in the minds of some people a fear that the machines will get out of order, break down, or be subject to some other dire catastrophe while in use at an election. It is *possible* that this might happen. But if persons possessed of such fears were familiar with the strain and risk of preparing the present paper ballots and getting them into the hands of the voter on election day, they would doubtless agree that the danger with machines is no greater than that connected with the present method.

Machines cannot of themselves secure honesty in all election matters. They will, however, greatly reduce the opportunities for dishonesty. Semaphores have not as yet been able to insure absolute safety in railroad travel; yet no one would advocate a return to the old system of signals on account of the wrecks



THE INSTRUCTION MODEL.

that have occurred by reason of the semaphore's failure to perform its functions accurately at all times.

Are Simple to Operate

The mechanical construction of the average voting machine is not complicated so far as the voter is concerned. In fact it is quite simple and capable of being understood by the most inexperienced. There is less to understand and less to learn in voting by machine than by paper ballot. Complaint is made in some quarters that the voting machine encourages the voting of the straight ticket. This complaint is not the fault of the machine, as without doubt any of the machines now in use in any State will

permit as many different kinds of voting as the law of that State allows. No machine could be legally used that did not permit the voter as great latitude as the law provided in expressing his choice. The difficulty is that voters, in many instances, fail to inform themselves sufficiently before entering the booths as to how to vote, and seek to blame the machine or the system for their own inefficiency.

General View of Dean Voting Machine.

A considerable number of different makes of machines are now in the market. Without exception they all make it vastly more simple to cast a split ticket than under the Australian method.

Easy to Split Tickets

The Australian ballot, when the law was first adopted, and after its initial use, was opposed by a great many persons, and its repeal advocated, for the reason, as alleged, that it encouraged and facilitated the voting of the straight party ticket, and further that it was capable of being understood only by the most intelligent. The criticism directed against machines has the same familiar sound.

Experience with any real reform teaches that, to be understood and made effective, its requirements must be studied. The faith that good laws will automatically produce good results is too much relied upon. The determination to try to make the best use of the means provided for the accomplishment of desired results, is the spirit that is needed.

It is the almost universal experience that voting machines present the following advantages over any other method of registering the will of the people:

They compel every voter to vote in secrecy.

They make it mechanically impossible to cast a defective ballot. In Illinois alone, at every general election, 40,000 voters lose their votes because of wrongly marked paper ballots.

They cannot be made to show a false result.

They save time and prevent errors. When voting is ended, counting is ended.

They largely reduce the cost of elections. The city of Buffalo, N. Y., saves $12,000 over the Australian system at each election.

They do away with election contests and recounts.

Should be Introduced Gradually

In some cities the election authorities have introduced machines in all precincts

VOTER ABOUT TO CLOSE THE CURTAIN.

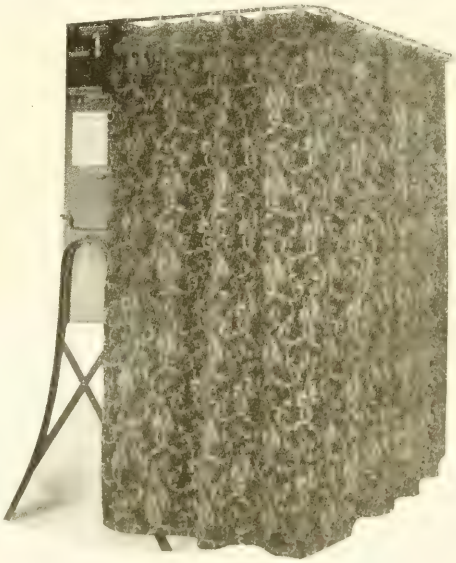
simultaneously and caused them to be used the first time throughout a whole city at once. Better results, without doubt, would have been obtained had the machines been introduced gradually—say by the equipment of one-third of the precincts at each succeeding election until the full quota is secured. By that arrangement, the election authorities, as well as the voters, would have gained a familiarity and experience beneficial to both; and the criticism that the machines were not understood would not now be heard. It is bad policy to institute a great innovation, such as the installation of a large number of voting machines, without first gradually educating the community to its use. San Francisco's experiment would undoubtedly have been more satisfactory had the authorities introduced the machines gradually instead of placing them simultaneously in every precinct.

Will Cut Down Election Expenses

The use of voting machines would lessen election expenses. At present Chicago has 1,254 election precincts. The use of machines, based upon the law, would reduce this number to not more than 900. Estimated on that basis, the use of voting machines during 1905 would have saved, in the pay of judges and clerks of election and in rent of polling places, the sum of $76,200. Probably the added expense of storage and skilled care of the machines would reduce this saving several thousand dollars.

It is maintained by some that machines can easily be made to record or add in an incorrect or fraudulent manner, by such devices as rubber bands, toothpicks, or screws. To anyone even partially conversant with the use of machines, tampering in this manner seems possible but stupid. That part of the machine open to operation is exposed to the full view of the voter, and is practically the only part handled by him. It does not appear possible that a voter would purposely deprive himself of a vote; and if he saw such a device attached to the machine and permitted it to remain there, it is apparent that he would be of no greater intelligence than a voter who would accept a ballot already marked handed to him by a judge of election. It is tantamount to saying that a voter would willingly see himself robbed of his legal rights.

At the election of November 7, 1905, Chicago used ten voting machines of seven different makes, all of which worked satisfactorily and permitted the returns to be made in a marvelously short time after the close of the polls. The precincts in which the machines were used contain voters of every nationality and of



CURTAIN CLOSED. VOTER INSIDE, VOTING.

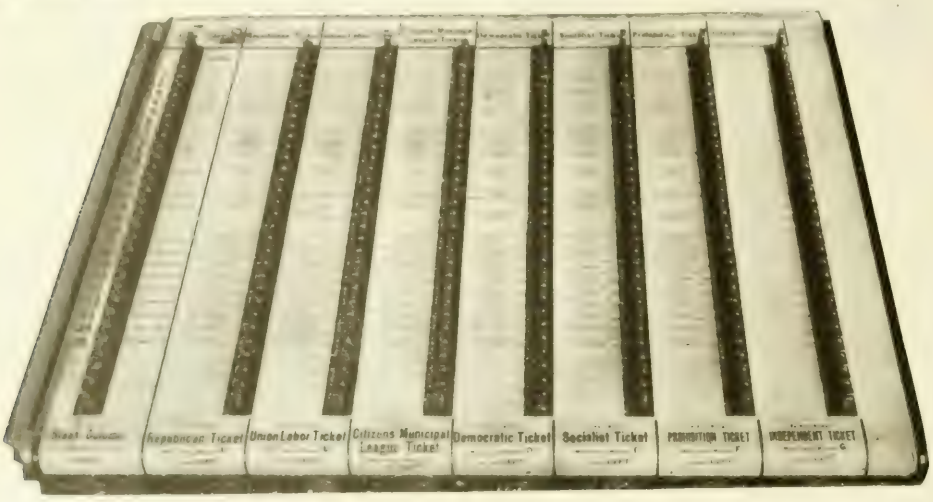
almost every degree of intelligence. It was the aim of the election authorities to test the machines under all possible combinations of conditions. In no instance was difficulty or inconvenience experienced, or anything but commendation of the machines expressed. Rivalry existed in the precincts in every part of the city to secure the assignment of a machine, and undoubtedly the voters in all the precincts would have been pleased to have had the machine used therein.

Are in Line of Progress

The use of voting machines for the past ten years and the constant increase

should be discarded and something better installed in its place.

We have honest elections in Chicago, and the writer has no personal information that elections in other communities are not of the same character. There is a feeling apparent, however, that a better method of voting is available than by use of the paper ballot. No one will know until it has been tried and tested, what advantages the machine offers in a given community as compared with the paper ballot. We can only justify our belief in its efficiency by the experience of other communities and the experiment made in a limited way in Chicago.



TOP OR FACE OF DEAN VOTING MACHINE.

This shows a vote for straight Democratic ticket and on questions. The levers by which the votes are cast, located under the front edge of this face, are shown in the cut on page 712.

in the number in operation, is evidence that election methods are keeping step with the movements in all other lines of progress. The people are no longer satisfied to ride in canal boats or slow-going coaches. It is reasonable that improvements in almost every line of civilization should affect the voting public, which is no longer content to tolerate a slow and cumbersome method, however approximately accurate it may be, when a more modern and absolutely accurate system is to be had. The argument that any system, no matter how efficient, will not prevent fraud, does not avail. It is the duty of the authorities to install the best system to be had; and when that becomes weak and subject to abuse, it

Information gathered from many different parts of the country indicates a healthy degree of satisfaction and contentment where machines have been used. The manufacture of voting machines is yet in the stage of infancy, and will constantly improve; and, as their use is extended, their weak spots will be discovered and the election laws will be modified accordingly, so as to insure a greater degree of accuracy and inviolability.

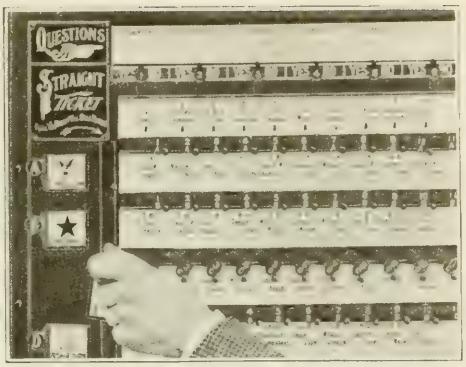
Changes in Law Necessary

One impediment in the use of voting machines in some communities, is the large number of candidates to be elected at one time. This can be avoided, however, by causing the dates of the election

for some of the offices to be changed. Legislative action would be necessary; but, when done, the merit and virtue of voting machines would be greatly enhanced. We have too many elections in Chicago, and elect too many officers. As a change in either seems impossible, the next thing most desirable would be one election in each year, to be held in November, the municipal elections being held in the odd-numbered years, and the County, State, and Congressional elections in the even-numbered years.

In a number of scattered communities, the recent election has demonstrated that the inactivity of voters and the indifference to election laws and methods in such communities have been chiefly the cause of unpopular results, the voters seemingly being ignorant of their legal rights. In other scattered communities it has been shown that where a quickened public conscience was to be reckoned with, whatever the system or the law, no just complaint as to the results has been made.

Where the voting machines were used, some criticism has been made as to the character of the voting (as to the number of straight or split votes), but the honesty of the voting or the accuracy of the count has not been questioned. The experience had with the machines, and the advantages they offer, seem to demand their use. The necessity for their adoption requires no argument.



VOTER ABOUT TO PULL THE PARTY LEVER OF HIS CHOICE.

Brilliants

ART thou weary, tender heart?
Be glad of pain;
In sorrow, sweetest things will grow,
All flowers in rain.
God watches, and thou wilt have sun
When clouds their perfect work have done.

Sweet friend, perchance both thou and I,
Ere love is past forgiving,
Should take the earnest lesson home,—
Be patient with the living.

Through love to light! Oh wonderful the way
That leads from darkness to the perfect day!
From darkness and from sorrow of the night
To morning that comes singing o'er the sea.
Through love to light! Through light, O God, to Thee,
Who art the love of love, the eternal light of light!

—RICHARD WATSON GILDER.

DIVING FOR SALT ON THE SHORES OF THE DEAD SEA.

Diving for Salt in the Dead Sea

Primitive Industry Pursued Amidst the Awful Desolation of the Desert

By WILLIAM GEORGE

THERE are in the Holy Land but few industries, and these of the most primitive kind. The awful desolation of the Dead Sea, however, which lies nearly 1,300 feet below the level of the Mediterranean, is broken here and there by the salt-divers, whose work is probably as ancient as the human race itself. From remotest antiquity the salt of the Dead Sea has been collected and brought to the Jerusalem market, where it is used for curing hides and for domestic purposes.

The entire Sea is a singular phenomenon. It is calculated that at least 6,000,000 tons of water fall into it yearly, the whole of which must be carried off by evaporation; for it is not conceivable that so low a salt lake should have any outlet. Nor is it difficult to imagine that the sweltering hot and dry air of this region should be capable of absorbing so enormous an amount of moisture.

Consequently the water remaining behind is impregnated to an extraordinary extent with mineral substances, as well as with salt of great strength, which it dissolves from the beds of clay on the banks. Dead Sea water contains over 25 per cent of solid substances, of which 7 per cent is chloride of sodium, or common salt. It is chloride of magnesium which gives the water its horribly bitter taste; while the chloride of calcium makes it feel smooth and oily to the touch, so that after the very curious sensation of a bath in the Dead Sea, the skin retains an oily sensation.

The Dead Sea contains no living creature; sea fish put into its waters speedily die. Not a single boat navigates its strange waters nor is there any sign of life, save the isolated parties of salt-divers, who scrape and slowly amass their precious glistening heaps of crystal near the mouth of the Jordan.

When a sufficient cargo is made ready, a long string of camels crosses the desert; and the salt is loaded up into panniers or "shwerries," and taken into Jerusalem, where it finds a ready market. Salt, as is well known, has been used as currency from time immemorial, just as bricks of tea are used to-day in Central Asia, especially in the borderlands of China and Siberia.

Vast Water Power is Wasted

Great Rapids of St. Lawrence River Develop More Energy than Niagara Falls

By ALTON D. ADAMS
Consulting Engineer

THE Saint Lawrence river develops more power than Niagara Falls.

Between Lakes Erie and Ontario, the Niagara river descends 327 feet; and from Ontario to the ocean, the St. Lawrence falls 246 feet. Of the entire difference between the Erie and Ontario levels only 215 feet are covered by the upper rapids and the great Cataract. Thus, while the volume of St. Lawrence water is larger, its total descent is also greater, than that of the upper rapids and Niagara Falls combined.

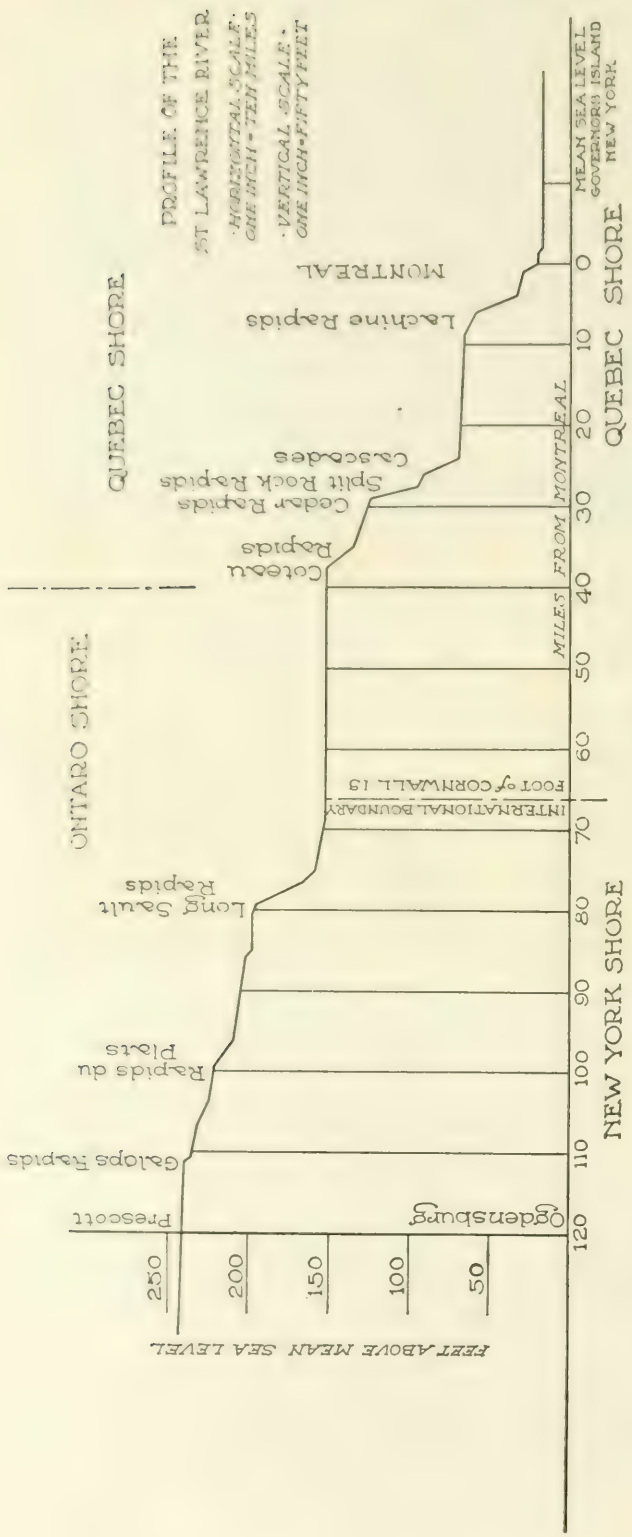
Not All Power Can be Utilized

But not all of the power in St. Lawrence waters can be utilized. At Montreal, just below the Lachine rapids, the water level of the river is 18 feet above mean sea-level at New York, and from this point to the ocean no power can be utilized. So, again, from the head of the river at Lake Ontario, down past the Thousand Islands and the cities of Ogdensburg and Prescott, to the head of the Galops rapids—a distance of about sixty miles—the fall of the St. Lawrence is only about four feet. But from the head of the Galops to the foot of the Lachine rapids at Montreal—a distance of some 113 miles—the fall of the river is 224 feet. All water that passes Niagara Falls, save the small amount lost by evaporation, goes down the St. Lawrence River; and to this must be added the discharge of many small rivers in the United States and Canada that flow into Lake Ontario and its outlet. In both tonnage of water and feet of fall the St. Lawrence river thus has greater power capacity along this 113 miles of its course, than has the Niagara from the head of its upper rapids to the foot of the cataract.

Neglecting the discharge of the many smaller rivers that join the Lake Ontario system, the normal flow of 222,000 cubic feet per second from Niagara alone develops more than 5,600,000 horse-power in the St. Lawrence between the head of the Galops rapids and Montreal island. If the fall of 224 feet were evenly distributed along this 113-mile stretch of the river, it might be impracticable to utilize its power; but such is not the case. The fact is that four series of rapids, with a combined length of 44.6 miles, in this part of the river, have a total fall of 205 feet. The Galops rapids are the highest of the series; and from their head to a point 15.4 miles down stream, the fall of the river is 31.5 feet. Then comes a stretch of 15.7 miles of comparatively smooth river to the head of the Long Sault rapids, carrying the water level down 44.5 feet in a distance of 6.7 miles. At the foot of the Long Sault rapids is Lake St. Francis, whose surface falls only 0.9 feet in a length of 31 miles above the Coteau rapids. From the head of these last-named rapids, down over the Cedars and the Split Rock and Cascades, the St. Lawrence drops 83.2 feet, in 14 miles. This brings the river to Lake St. Louis, on which there is a fall of only 1.6 feet in level for its length of 15.25 miles. At the outlet of this lake, the river makes its last large fall, of 46 feet, over 8.5 miles of the Lachine rapids, and thus reaches the lower end of the island of Montreal, only 18 feet above mean sea-level at Governor's Island, New York.

Canals Are Necessary

From the above, it may be seen that the fall of the St. Lawrence is so dis-



tributed that rather long canals or pipe lines are, as a rule, necessary to concentrate desirable heads of water for power purposes. Thus, from the head of Galops rapids, a canal about 15.4 miles long will give a fall of 31.5 feet; from the head of Long Sault rapids, a canal about 6.7 miles long will give a fall of 44.5 feet; from the head of Coteau rapids, a canal about 14 miles long will give a fall of 83.2 feet; and from the head of Lachine rapids, a canal 8.5 miles long will give a head of 46 feet, neglecting the moderate slopes necessary in such canals. Galops and Long Sault rapids give 76 feet; and combining the falls along the Coteau rapids, the Cascades, and Lachine rapids, gives 129 feet—a total of 205 feet fall that is capable of development for power purposes, at moderate cost.

The classification just made of the main rapids of the St. Lawrence into two upper and two lower sets, derives interest from the fact that the two upper sets of rapids, with their combined fall of 7.6 feet, are in that part of the river which separates the United States and Canada, while the two lower sets are entirely within Canadian territory. Canada thus has the exclusive right to about 63 per cent of the power of the St. Lawrence that can be most readily devoted to useful purposes, besides an equal right with the State of New York to the remaining 37 per cent.

Vast Amount Could be Developed

Basing calculations, again, on the 222,000 cubic feet of water per second, dis-

charged by the Niagara river at its normal stage, and neglecting the large but uncertain volume of water that flows into Lake Ontario and the St. Lawrence from numerous smaller rivers, it appears that the fall of water at this rate through a distance of 205 feet develops 5,130,000 gross horse-power. Assuming that canals or pipe lines would deliver 80 per cent of the 205-foot head to turbine wheels, and allowing for such wheels and their connected generators the fair combined efficiency of 70 per cent, it appears that the four sets of rapids named in the St. Lawrence river can be made to develop 2,872,000 electric horse-power. Of this total about 644,000 horse-power can be produced near the Lachine rapids, 1,165,000 near the Coteau rapids and the Cascades, 623,000 near the Long Sault, and about 441,000 electric horse-power near the Galops rapids.

SPLIT ROCK RAPIDS, ST. LAWRENCE RIVER.

Might Interfere with Navigation

Whether the diversion of this great volume of water along the rapids would interfere with navigation, is an open question; but it seems probable that navigation and power development will ultimately be carried on with the same canals.

With its characteristic neglect of inland waterways, the Federal Government of the United States has left it for Canada to construct the canals that make possible navigation through the St. Lawrence of vessels with fourteen feet draught. Six of these canals parallel the several series of rapids between Montreal and Lake Ontario; and these canals now offer excellent opportunities for power development.

Around the Lachine rapids there is a single canal; and the same is true of the Coteau and Cedars rapids and the Cascades, and of the Long Sault rapids. In each of these three cases, the single canal makes the entire fall along the rapids available for power production. Between the head of the Galops rapids and the first nearly smooth stretch of river below, there are two canals, one below the other, so that neither maintains a head corresponding to the entire fall. As the demand for electric power increases, the canals at the Long Sault, the Coteau and Cedars, and the Lachine rapids, seem likely to be used for its production. At the Coteau and Cedars rapids and the Cascades, which have a combined fall of 83 feet in 14 miles—much the largest fall for any equal stretch along the entire river—the Soulanges canal, which parallels this entire series of rapids, is

STEAMER *ALGERIAN*, RUNNING LONG SAULT RAPIDS.

already being utilized for the development of electric power.

Something Already Done

While the Canadian Government has laid a foundation for great power development along the north bank of the St. Lawrence, private enterprise has achieved more immediate results in this direction on the south bank, in New York State. This is the work of the St. Lawrence River Power Company, at Massena, where a hydro-electric plant of 150,000 horse-power ultimate capacity, and 35,000 horse-power present equipment, has been constructed. The enlargement of this plant, and the erection of others, seem likely to follow as the great advantages of the region for power development become better known. These advantages consist not only in the fall of the St. Lawrence along its two upper series of rapids, but also in the physical geography of northern New York, which is particularly favorable to the development of their power for industrial purposes. In fact, Nature seems to have done about as much to make power development along the St. Lawrence easy in New York, as the Canadian Government has across the river. This situation is created by the Raquette, La Grasse, and one or more smaller rivers of northern New York, that flow substantially parallel with the Saint Lawrence from the head of its highest rapids down to the international boundary line at the upper end of Lake St. Francis. Importance attaches to the parallel courses of these New York rivers, because their beds lie much below the level of the St. Lawrence for rather long distances, over which the greater and the lesser streams are only three to five miles apart.

Tapping a Smaller River

From the head of the Galops rapids, about eight miles below Ogdensburg, to the international boundary line near the foot of Cornwall island, a distance of 45 miles, the St. Lawrence river falls 89 feet, 76 feet of this fall being concentrated in about 22 miles of rapids, as above mentioned. Between the head of Long Sault rapids and the mouth of the Raquette river, off Cornwall island, about 10 miles down stream, the fall of the St. Lawrence is 47 feet. For a distance of 15 miles from its mouth, over that part of its course which parallels the Long Sault rapids, the Raquette river is only two to four miles from the St. Lawrence, and its surface is fully 45 feet below that of the greater stream. A short canal between the two rivers at any one of numerous points along their parallel stretch of 15 miles, will thus give a water head of as much as 45 feet for power production. By locating its power house on the bank of the La Grasse river, at Massena, and bringing water from a point on the St. Lawrence about two miles above the Long Sault rapids, by a canal 16,200 feet long, the St. Lawrence River Power Company obtains a head of 45 to 50 feet on its turbine wheels, according to the stages of the water in the two rivers. The canal of this company was designed for navigation as well as for power production, is 192 feet wide at the water line and 140 feet at the bottom, has a depth of 18 feet at the St. Lawrence and 20 feet near the forebay,

ST. LAWRENCE RIVER POWER COMPANY AT MASSENA, N. Y. Power house interior showing switchboard, aluminum conductor bars under gallery, alternators, and two exciters.

and floats the largest vessels that can ascend to Lake Ontario. On leaving this power plant the water follows the channel of the La Grasse river to its mouth, on the St. Lawrence, near the head of Cornwall island, seven miles down stream.

About two miles from La Grasse river, and parallel with it over the lower ten miles of its course, is the Raquette river,

BIG JOHN AND PARTY SHOOTING LACHINE RAPIDS.

which also joins the St. Lawrence a little on the New York side of the international boundary. When desired, the bed of the Raquette river, like that of the La Grasse, may be used as a tailrace for water drawn from the St. Lawrence for power production. Parallel with that part of the St. Lawrence which extends 15 miles down stream from the head of the Galops rapids, dropping 34 feet in the distance, there is a small river three to four miles distant from the New York bank of the greater stream. This small river discharges into the St. Lawrence nearly opposite the Canadian town of Morrisburg; and while data are not at hand to warrant a positive statement, it is not improbable that another natural tailrace is thus provided.

Enough facts have now been presented to make it plain that the St. Lawrence river can readily be made to yield tens of hundreds of thousands of horse-power.

The next problem is to find a use for any large part of this power; and much of this use, it will perhaps be conceded, must be local to the St. Lawrence valley. A decided tendency in this direction may be noted at Massena, where by far the greater part of the electrical energy developed is consumed by manufactories. In a single building of one manufacturing plant at Massena, 12,000 electric horse-power is used in the production of aluminum.

How the Power May be Used

Some suggestions as to the uses to which the St. Lawrence power may be put in the line of manufacture, are seen in the fact that pulp wood comes to Massena and other points along the rapids entirely by water transportation; and that St. Lawrence county, New York, along whose northern border the fall of 76 feet in the rapids occurs, contains large deposits of magnetic hematite, and specular iron

ore, graphite and talc. The low cost of development and the constancy of St. Lawrence power should make it especially attractive for electro-chemical industries.

But the power of the great river may be transmitted over an area much greater than that of its own valley. All of that part of New York State north of Glens Falls and Rome, a region of mines, quarries, pulp mills, and cement works, is within easy reach of electric lines from the St. Lawrence rapids. The same is true to a large extent of a large area in Canada, north of the river, where manufactures are on the increase. Cities and towns are demanding a portion of the cheap and constant power that the St. Lawrence can supply. Plans are now under way for the delivery in Montreal of a fraction of the energy liberated at the Coteau rapids and the Cascades below. Watertown and other cities in northern New York are being connected by electric lines with Massena.

Really long transmissions would bring St. Lawrence power to many large markets. Massena and Niagara Falls are each about 145 miles distant from Syracuse, New York; and to all points between Syracuse and Albany, a Massena transmission would have the advantage in the matter of distance. From Massena to Burlington, Vermont, by a practical route, is about 120 miles. Albany is 144 miles from Massena; and Troy and Schenectady, somewhat less. If New York City is to use power developed with the water of the Great Lakes, the St. Lawrence rapids are in a position to compete in the service, for, while they are a little less than 300 miles from the metropolis, Niagara Falls are somewhat more than that distance away.

Dictating Letters By Telegraph

Unique Office Contrivance of Fourth Assistant Postmaster-General DeGraw, and Its Many Uses

By WILBERT MELVILLE

PETER V. DEGRAW, Fourth Assistant Postmaster-General of the United States, has recently installed, and now has in daily operation one of the most unique adjuncts ever adopted by a government official.

Between his private office and the adjoining room occupied by his private secretary and confidential stenograher, there is in operation what is undoubtedly the shortest complete telegraph line in the world. It is a well-known fact that old telegraphers would far rather talk over the wire than face to face. Instances are numerous where an applicant for a job in a telegraph office would go into

some branch office and make his request over the wire to the manager, when he could have made it in person with less trouble. Operators claim, too, that they can converse as rapidly in this way as verbally. It is this peculiarity of the cult which accounts to a great extent for

FOURTH ASSISTANT POSTMASTER-GENERAL PETER V. DE GRAW, DICTATING A LETTER TO HIS STENOGRAPHER, WHO IS IN THE ADJOINING ROOM.

the existence of the Postoffice Department "short line."

Mr. DeGraw, his private secretary, Mr. W. H. Allen, and his stenographer, Mr. Prender, are all old experienced telegraphers. Upon the desk of each is a complete sending and receiving apparatus, and Mr. DeGraw says he finds it a most convenient thing in the course of a day's business. By the use of his private line, he can call for papers wanted by him, without leaving his private room or interrupting in any way the important conferences that take place daily in his office. If a message reaches the office for him, his secretary can send it in to him, should he be occupied; and he can send a reply without the fact being known or causing any interruption to the business upon which he may be engaged. The Fourth Assistant is not only a telegrapher but a good one. For a long time prior to his connection with the government service, he held the record of the office with which he was connected for fast sending; and by availing himself of his skill in this direction in the discharge of his new and more important duties, he hopes to facilitate the transaction of business in his office to an extent that will materially increase its efficiency.

Concrete Wall Defies Niagara

How the Dangers Resulting from Erosion and Ice-Formation in the Niagara Gorge are Dispelled by Man's Ingenuity

By ORRIN E. DUNLAP

THE Niagara Falls Hydraulic Power & Manufacturing Company has been applying concrete work to its protection in a very remarkable manner. This company owns the surface power canal that runs through the city to the high bank of the gorge on the American side of the river. The canal is 4,400 feet long, and empties into a basin located 300 feet back from the cliff. Short canals connect the basin with forebays located at the edge of the bank; and from these forebays huge penstocks extend or drop in column-like form to the company's power station, which is located at the water's edge in the gorge, a short distance below the upper steel-arch bridge. This company was the first to engage in the development of the power of Niagara. Its affairs are managed by Hon. Arthur Schoellkopf, with John L. Harper as chief engineer.

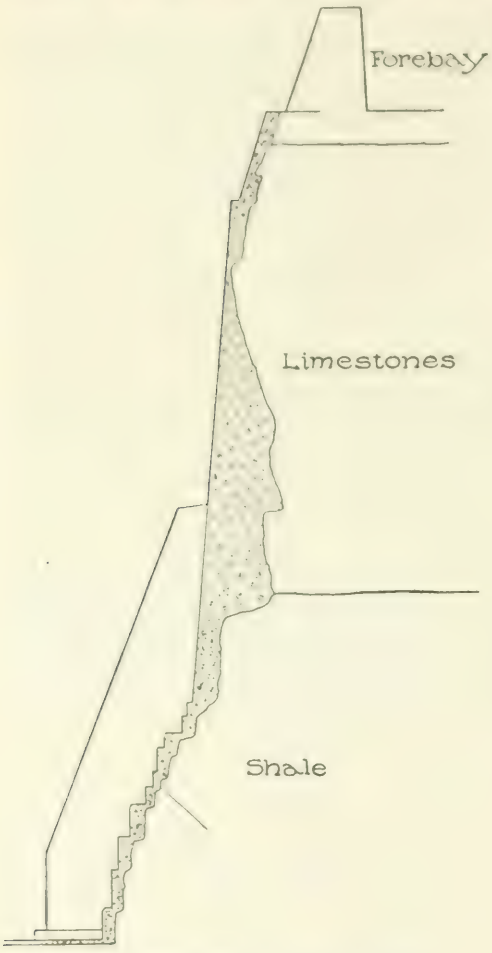
Gorge Lined with Concrete

When the site for the power house was cleared, the debris slope or apron at the foot of the cliff was removed. The cliff is composed of a thick layer of limestone at the top, supported by strata of shales underneath. When the slope was cleared away, the shales were left exposed to the action of the weather. The effect of this is best explained by pointing out that the beautiful Niagara gorge was excavated by the Horseshoe Fall of Niagara, which, by the process of erosion, has gradually eaten away the shale, leaving the limestone ledge of the upper river-bed projecting shelf-like. In time, the weight of the water and the rock breaks the latter away, and it tumbles into the lower river. At certain places, particularly in front of the American Fall, these fallen blocks of limestone serve as a protection to the shales, and the water does not eat them away as it does under the Horseshoe, where they are unprotected. Knowing that as the shales deteriorated, and by rain and freezing crumbled and broke away, the support of the limestone ledge at the top of the cliff over the power house would be endangered, the Niagara Falls Hydraulic Power & Manufacturing Company decided to face the cliff back of the power house with concrete from top to bottom. This would lessen the danger to the forebays on the cliff top, while also protecting the power station and the men employed there. Chief Engineer Harper designed the revetment; and just before the cold weather of the present season set in, it was completed.

This facing of concrete drops to the level of the tail-water, and rises 150 feet above the power-house eaves, making its total height 200 feet, while it is 200 feet wide. The concrete is a 1-3-5 mixture filled with clean rubble. At no place is the wall less than two feet thick, while in places it has a thickness of 12 feet. Previous to the construction of this facing wall, the cliff had been faced up to the shales, but at that time there was no thought that it would ever be extended to the cliff top. Under these conditions Engineer Harper deemed it advisable to construct three pilasters to give substantial support to the upper and heavier parts of the wall. Each of these pilasters is 80 feet high and five feet wide; and viewed from below, they have the appearance of being heavy enough to support the cliff.

During the progress of the work, a desire arose to protect a natural grotto in which a famous spring is located. This grotto is situated between two of the pilasters, and it was decided to protect it

with an arch. This was accomplished without in any manner detracting from the strength and usefulness of the wall. While there is considerable seepage from the bank, experiments made by Mr. Harper showed that the water back



SECTION THROUGH WALL OF GORGE SHOWING PROTECTING FACE OF CONCRETE.

of the wall never attained a temperature lower than 39° F. in the most severe weather. This would indicate no danger of freezing, especially as the removal of the water is provided for by weepers.

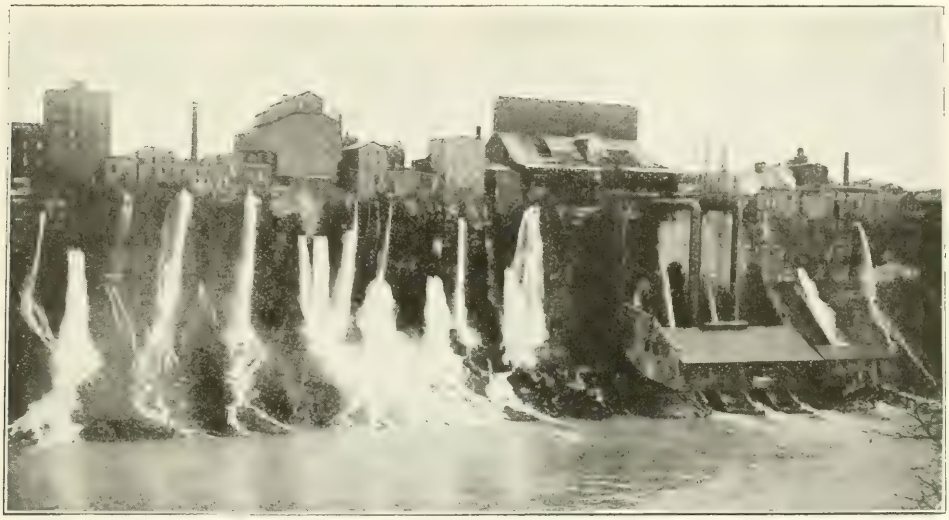
It is worthy of note that the wall contains about 7,000 cubic yards of concrete; and of this, from 80 to 90 cubic yards was placed daily. All the sand and stone used in the wall was dumped 300 feet back from the edge of the bank, at the side of a railway track, and was carried on an aërial cableway to the concrete mixer on the brink of the precipice. When ready, the mixture was dumped into chutes, which carried it to the point of use without causing any separation of the concrete, particular attention having been paid to see that the chutes were steep, smooth, and small so as not to cause any sliding or rolling of the concrete, but to have it slide as a unit.

It is intimated as an engineering feat for future years, that, if such a facing of concrete were built back of the Horseshoe Fall, the waterfall would no longer dig the gorge longer, but would forever be held at the point it had reached when the wall was built. Geologists agree that the ledge of limestone over which the Horseshoe tumbles dips to the south, and that, as the water eats away the foundation of the ledge, allowing it to break away, the fall will grow less and less in height and ultimately cease to exist. There is much discussion of why the Falls of Niagara should be protected from destruction at the hands of the power companies who divert its water. President Roosevelt, who was memorialized to advocate their preservation, has made scenic Niagara the subject of a paragraph in his annual message to Congress. It is evident that no matter how much man seeks to protect Niagara from the power companies, the falls will destroy themselves in time, if some such protection is not given to the shales under the limestone. Every second that the Horseshoe spills its waters into the gorge, it is committing suicide. But then, this generation need not worry over the fact.

A Concrete Protection Wall

Still another notable work in concrete that has been erected by the Niagara Falls Hydraulic Power & Manufacturing Company is a protection wall built along the north end of its power house in the gorge. This wall was made necessary by the great ice-mounds which yearly build at this point from the overflows and ice-runs of the mills located on top of the bank. All who are familiar with the conditions of the lower Niagara milling district, will recall these pretty water-

falls as they grace the American bank. While they are pretty in summer time, in winter they develop a source of danger; and it was to overcome this that the protection wall was built, as it is designed to stop icicles or other bodies of ice that may start down the ice-mounds toward the power house. The protection wall extends from the face of the cliff 150 feet to the side of the power house nearest the river. Its greatest vertical section is about 75 feet in height, and it extends 10 feet above the highest part of the roof. It has a thickness of five feet, and it is reinforced where necessary with steel beams. The concrete used in its construction was a 1-3-5 mixture. The foundations were taken down to solid rock at all points except under about 15 feet of the end nearest the river. This section was built out from the rock and strengthened with built-in iron work, so that it makes practically a cantilever truss at this point. Two window openings were left in the wall, for the ventilation of the power house. These windows are protected with structural steel shutters that make the windows waterproof in winter. It has been a success as to both form and protection; and confidence prevails that it has sufficient strength to withstand any ice conditions that may arise. Last winter a piece of ice estimated to have weighed 25 tons fell from the high bank, and started down toward the power house. The wall stopped it, and was not cracked or in any way injured. This was accepted as a receipt in full for the cost of the wall.



POWER HOUSE AND LOWER RIVER FRONTAGE OF THE NIAGARA FALLS HYDRAULIC POWER & MFG. CO.

View from the Canadian side, taken Nov. 9, 1905, showing concrete facing wall completed over the power house; also protection wall at the end of the power house.

All the concrete used in the wall was mixed on top of the bank, and taken to place by an aërial cableway. It was dumped into place by means of large bottom-dump buckets that were operated from the top of the high bank. This wall also was designed by Chief Engineer Harper.

Poison—Man's Best Friend

Deadly Principles in Nature Which Have Chiefly Inspired Progress in Civilization

By HOLLIS W. FIELD

"POISON," as a single word of the English language, carries with it more instinctive warning and repugnance than invest any other word in the glossary of English speech. Whether spoken or written, the word at once challenges the attention and stimulates the imagination to horror of evil. There are only three poisonous serpents in the geography of North America, yet because of these three varieties alone the whole reptilian family is condemned to death at sight.

And yet, strangely anomalous as it may appear, the existence of active poisons in the animal, vegetable, and mineral kingdoms of nature has done more for the development of modern civilized man than have all the other innocuous elemental things which aboriginal man found to his hand. These active poisons were man's first stimulus to thought. Even in the figurative Eden there was one fruit of which man might not eat. "Why not?" was his question, and the only rational answer was for him to eat and see.

Poisons Inspired Civilization

Waiving aside this literal Eden as apocryphal and metaphorical, the aboriginal man was confronted by the same literal condition as to the things which he should not eat, or touch, or smell. His environment was that of the torrid zone. Nakedness was his condition. Exposure to the venoms of animal, plant, and mineral life was a consequence against which only a quickened intelligence could insure immunity. The fruit of one plant he discovered to be life; the touch of another was death. He could avoid the giant carnivora of the jungle which would have searched him out with tooth and claw; but he had little resource against the creeping, crawling things whose fangs and stings meant convulsive sufferings, horrors, and death to his kind. He knew the sweet waters of the hills, but must learn to guard against the brackish, excoriating waters of the deserts. "Why?" became in this manner his first voiceless question, and the stimulus of the interrogation was the making of civilized man.

How Poisons Are Mastered

To-day the word "poison" carries with it instinctively the old terrors which the elemental substance inspired in the aborigine. Largely it is a reflex, however; and to-day it may be said that as civilized man has mastered and is mastering the poisons of animate and inanimate nature, so is his measure of civilization to be taken.

How far civilization has gone in this mastery of the subject of toxicology may be a revelation to the layman. The materia medica has gone so far as to declare every effective remedial agent in the pharmacopœia a poison, more or less active and irritant. In Mother Earth herself lurks the germ of tetanus, one of the deadliest enemies of man. Water, clear and colorless as air, may be the nursery of poisoned poisons. And Death in hideous mask may be winging in the scented breezes of summer.

Was Man's First Problem

Recognizing these poisonous things of earth was man's first problem. Doing so, it was with intent to avoid them. But, as his knowledge of poisons grew and as his observations and experiences ripened, the possibility of utilizing their forces to his own ends was awakened; and these possibilities have grown as man's mental processes have grown, until in these early years of the twentieth century it would be difficult to say how far-reaching would be the consequences if the virulent poisons of the vegetable

and mineral kingdoms especially were to be swept into oblivion.

Doubtless the poisoned arrow was the first adaptation of poison to the uses of man. The aborigine found himself at once the hunter and the hunted of creation. Whether as hunter or the hunted, he was a pygmy compared with many of the carnivorous beasts of his environment. He saw that whereas his own considerable physical force and power were as nothing to some of these creatures, the fang of the serpent was all-compelling. Where the poisonous serpent struck with poisoned fang and killed its quarry, he saw it eat without discomfort or injury. To kill his own food through the venom of the serpent must have been one of man's first elaborated mental processes. As this aborigine applied the venom of the serpent to his arrow, and later blended it with the poisons of the vegetable world, he may be said to have grown in mental stature.

MASTERS OF THE "HOODED DEATH."

Used to Poison Arrows

Among the bushmen of desert South Africa, this arrow poison, almost universally, was from the poison ducts of the snake and spider, or from the entrails of a poisonous caterpillar. Only the bushmen of Australia compare in lowness in the human scale with these aborigines of Southern Africa, and that the African had recourse only to animal venom for his hunting arrow, is significant of his mental stature in that beginning.

Elsewhere in tropical Asia, Africa, and South America, it is found that the higher type of the aborigine has been quick to apply the poisons of the plant world to his uses in the chase. To-day the anthropologist, by considering only the character of the arrow poisons used by the world's aborigines, is competent to venture a broad approximation of the scope of tribal life using them.

Next Step to Vegetable Poisons

The curare of the South American Indians was one of the most deadly of injected poisons, and yet one of the least harmful in possibilities when the victim of the arrow was converted into food. The one-hundredth part of a grain injected into the blood of a rabbit kills it almost instantly, yet the animal may be eaten with impunity. An almost infinitesimal portion of the poison kills the largest of the carnivora and herbivora of the country, against which the un-

AN ORIGINAL COMPOUNDER OF POISONS.

venomed barb of an arrow might have no appreciable effect. Yet, as an example of the higher order of the curare makers, this poison is from the strychnine family of plant life, indicating protest against the use of an animal poison in overcoming animals for the larder.

How wide may be the world history between curare, kombe, and arquah poisons, and the administration of one-sixteenth of a grain of strychnine as a heart stimulant, always will be speculation. But the strychnine of the materia medica is identical with the plant bases of these arrow poisons. In this fact alone is suggestion enough, that, in his mastery of the world's active poisons, man has risen steadily in the scale of intelligence and civilization. Both inspiration and confidence have come to him in the processes, until his acme of attainment in this line may be grasped in the fact that the greatest factor in present international civilizations is dependent upon one of the most virulent poisons known to the chemical laboratory.

Gold Due to a Poison

Gold is this great factor in international trade relationships, without which civilizations would experience industrial and commercial paralysis.

Cyanide of potassium is the poison of poisons, without which the world's production of gold, present and prospective, would assume alarmist proportions not only to the financier, but to a hundred industries in which gold as a substance is vital. Every year it may be said that $15,000,000 worth of gold is added to the world's wealth by the cyanide process—gold which otherwise would have passed out as "tailings" from other processes, or which would have lain untouched in the heart of the refractory ores containing it. Forty plants in the Transvaal country are using the process. Thirty plants in the United States are busy with it; and 35 per cent of the world's production of the metal depends upon the manufacture and control of this deadly poison, one-eighth of a grain of which is a medicinal dose, and five grains of which means death to an adult man.

How Cyanide Was Discovered

Scheele, in 1783, laid the foundations for the manufacture of cyanide of potassium. With prussiate of potash for its base, dried animal matter of any and all kinds was dumped into the superheated vessels containing the potash, together with iron filings and borings. A stone-like, black mass resulted from the cooling; and other processes brought the final lemon-colored crystals which resulted from evaporations of the solutions. From these crystals prussic acid was evolved, of which a 2 per cent solution is the pharmaceutical preparation, yet so powerful that four drops will kill a large dog. A chemist, putting a cyanide solution in a gold-lined dish in 1844, discovered that the gold was dissolved in the liquid. This was the beginning of the gold-plating process by the use of cyanide; and the further involvement of the poison came about in electroplating, in photography, and in treating refractory gold ores.

Vast Prospects Waiting

As the uses of the poison grew, the commercial demand suggested some other and cheaper method for the production of cyanide of potassium. The

spent oxides of the ordinary coal-gas works became the base for a new manufacturing process, by which the cost of the poison was divided almost in half. As suggesting the future of this poison in gold mining, there is a mining district in Utah showing a limestone deposit twenty to forty feet deep and stretching roughly eight miles by ten, this limestone carrying $6 to $20 worth of gold to the ton. Only the cyanide process avails in recovering the metal, the cost ranging from $3 a ton down to 70 cents. The proposition anticipates 5,000,000,000 tons of ore, which should yield $50,000,000,000!

SOUTH AMERICAN SAVAGES WHO USE POISONED SPEARS AND OTHER WEAPONS.

Coal products perhaps lead in carrying those useful poisons upon which modern civilization so much depends in an industrial way. Coal gas of the cities is one of the dangerously poisonous agents which has become indispensable. One thousand feet of it carries an ounce of the deadly hydrocyanic acid, and its asphyxiating and explosive characters are well known and considered. Carbolic acid is one of the deadly poisons incidental to coal-gas production; and as an agent in sanitation especially it has a field all its own. Coal-tar and its more or less poisonous colors have found their uses in the arts and crafts.

Lead and Its Effects

Lead, which in so many forms is indispensable to the civilized world, is at once one of the most unruly of the useful poisons. The number of forms which this metal takes in the modern industrial world tends to make the layman underestimate its poisonous qualities. One-third of a grain of it in a gallon of water renders the water unfit for the stomach. The perpetual menace of a lead-mining country may be the water which is affected by the lead ores. Not only do the smelted and manufactured products of the ore menace the consuming public, but in every stage of lead production the workers are menaced by it beyond the possibility of self-protection. Painters, plumbers, type-founders, typesetters, potters, glaziers, and glass-makers are especially exposed to the poisons of commercial leads. Colic and paralysis are marked symptoms of lead poisoning which may end in death.

How Quicksilver is Used

Quicksilver as a metal is another

poison widely used in the arts, dating far beyond the Christian era. The oldest mine of which there is a record was at Almaden, in Spain. Spain still leads the world in the production of the metal, of which there is an annual output of 8,500,000 pounds. The commercial metal is packed in wrought-iron cylinders

DRUGGIST'S POISON CABINET.
Poison enough to kill 25,000 men.

holding 76½ pounds each. Its chief uses are in gold and silver mining, in the manufacture of vermillion, in silvering mirrors, in thermometers, barometers, and in the manufacture of pharmaceutical preparations. Calomel is mercury's chief contribution to the pharmacopœia. In any form, mercury is an active poison; and the workers in the metal suffer from salivation, shaking palsy, vertigo, and cerebral troubles.

Arsenic, which once stood for the terrors of poisons in general, has long been a commercial product measured annually by tens of thousands of tons' production. Bohemia and Saxony are the chief sources of supply, some of it coming from the arsenical iron ores of England. Cobalt ores are the richest in the substance. The greens of wall-paper and of artificial flowers are contributed largely by this commercial arsenic; and for such purposes the drug is without a practical substitute.

Alcohol a Poison

Alcohol in its several forms is a pronounced poison. The wood alcohol of commerce is the deadliest of these spirits; and yet it has been coming into such general use as a substitute for the highly-taxed grain spirits that movements have been started to induce the Revenue Department of the United States to authorize the manufacture of a denaturized grain alcohol free of any tax whatever. Except for the revenue tax on the grain alcohol, it could compete with the horribly poisonous wood spirits. Potatoes will furnish alcohol in high proportionate quantities; and with the product rendered unfit for drinking purposes—as is done in Germany—the uses of the spirits in the arts exclusively should not subject it to the enormous tax placed upon the grain alcohol.

Alcohol is the base of almost countless commodities in use in almost every field of endeavor. It holds a first place as a preservative. It is an almost universal solvent for drugs and chemical substances. Germany, for example, uses 25,000,000 gallons of alcohol every year for commercial purposes; and these uses are multiplying rapidly. Ether, celluloid, white lead, photographic papers and plates, collodion, perfumes of all kinds, transparent soaps, fulminates and smokeless powders, varnishes, inks, and even the manufacture of an artificial silk are dependent upon alcohol; and in many of these combinations the substitution of the wood alcohol for the grain product may be productive of appalling calamity to the unwitting workers in these substances.

In the Poison Cabinet

It is in the pharmacopœia that man's knowledge of poisons has led him to their most radical uses. In these uses more than anywhere else, he has given evidence that he is master of toxicology. At the same time, in modern pharmacy, both the pharmacist and the statutes have worked to evolve the "poison cabinet," into which no pharmacist may go alone for the measuring and weighing of cabinet contents. That one pharmacist shall check another in the filling of any prescription involving a virulent poison, is approaching a custom more deeply inscribed than is written law.

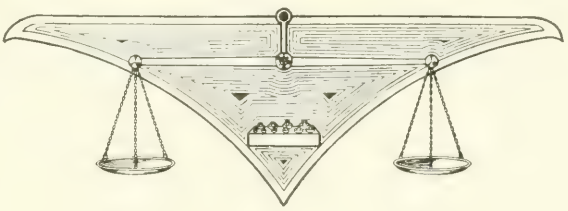
Perhaps no other one drug in such a cabinet suggests the horrors that attach to

corrosive sublimate. The one-hundredth part of a grain is a dose of the poison; a prescription that might call for one-fiftieth of a grain would be held out for investigation by a pharmacist. Companions of this poison that are behind lock and key are numerous, save as the pure drug has been mixed with seven parts of sugar of milk, making the mixture comparatively harmless.

Toll Paid to Deadly Drugs

Strychnia salts in sixteen forms may be in a druggist's poison cabinet. Arsenic solutions are several. Morphine, opium, and chloral hydrate are universally in use. Belladonna and aconite are powerful poisons. Atropine, a product of the belladonna root, is fatal in two-third grain doses. Tincture of Calabar bean, fishberries, and digitalis are essential to a full poison cabinet. Phosphorus, codeine salts, zinc salts, pulsatilla, and mercury in its several forms complete the chief features of the cabinet of poisons; and with such a collection of toxic agents, no law and no pharmaceutical skill have rendered the search for antidotes unnecessary. Accidentally and by design, hundreds of mankind every year are victims of poisons of the materia medica, while thousands become incapacitated or die from the manufacturing and consuming of the commercial poisons. India has its tens of thousands of fanatical victims of serpent bites. There are animal, vegetable, and mineral poisons against which there are no sure antidotes.

And yet all these facts and figures have a bearing on human progress. Each virulent poison and its antidote are milestones in the track of man's evolution.



In a "Flying" Laboratory

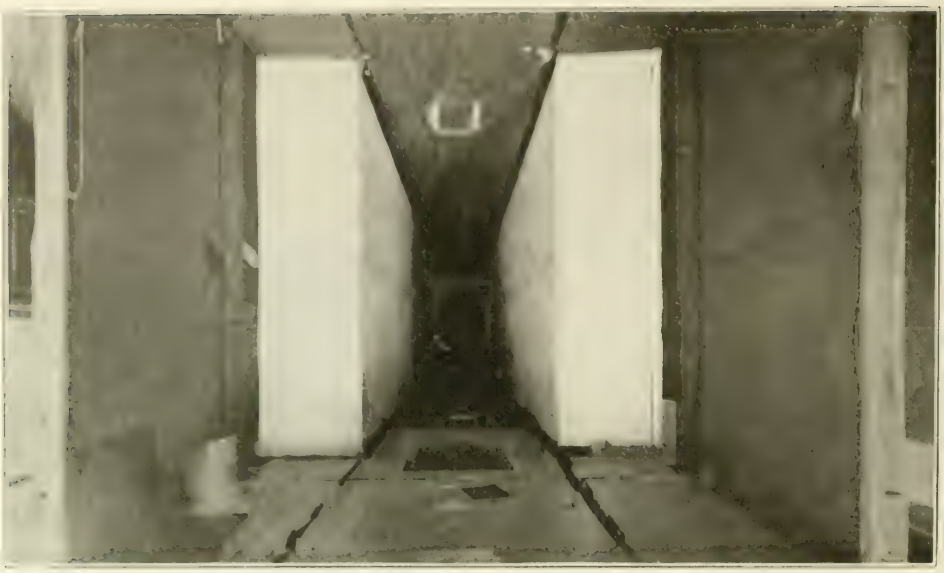
Unique Department of Scientific Work at the Catholic University of America, in Washington, D. C.

By B. R. WINSLOW

DR. ALBERT F. ZAHM, of the Catholic University of America, has for the past two years been conducting a series of experiments in aërostatics, under the auspices of the university; and he has done much toward solving some of the most perplexing problems in connection with aërial flight. So quietly has the work been done, that but few outside of a small circle of professional men know about it, or how much is due to the work of Dr. Zahm for establishing the existence of essential laws that have to be dealt with in building a practical flying machine. Although Dr. Zahm is not an aëronaut, and apparently is not ambitious to build an airship, he is intensely interested in the problem, and has done much practical work for which inventors have to thank him. He has kept in close touch with Chanute, Mindenhall, Professor Langley, Professor Bell, the Wright brothers, and Lord Rayleigh, all of whom are interested in the same problem, and he has gained some valuable practical results in his laboratory work.

An Experimental Air Tunnel

The aërostatic laboratory is a wooden structure specially constructed for the purpose. It is 80 feet long by 20 wide



INTERIOR OF WIND TUNNEL.

merely a one-story shed. Its chief equipment is a wooden tunnel 6 feet square and 40 feet long, so constructed that its diameter can be reduced at will when lighter wind velocities are required. Air is forced through the tunnel by a five-foot fan situated at the far end of the passage. The other end is closed with a door covered with a cheese-cloth screen that serves to straighten out the air currents, which would otherwise be turbulent. The laboratory was originally built and equipped by Mr. Mindenhall, who wanted some practical demonstration of what he thought was a practical flying machine, before he put money into actually building one.

Air Pressure Measured

The tunnel is equipped with a delicate anemometer, by which the wind pressure and velocity in the tunnel are measured to a nicety. The anemometer works much on the same principle as a steam gauge, and is capable of recording velocities of from five feet a second up to forty feet. There is also a delicate weighing machine, which is situated above and outside the tunnel. The purpose of this machine is to weigh, or measure, the wind pressure on models suspended in the tunnel. These models are of various shapes, and so constructed that their parts are interchangeable; thus, by a combination of parts, a large variety of shapes are secured. The models are suspended in the tunnel by means of a steel rod, which is connected to the weighing machine, and in this way the air resistance of each shape and size is accurately recorded. The recording machine is mounted on top of the tunnel, with the steel arm projecting through the roof. To the end of this arm, which is protected from the wind by a shield hung in front of it, is attached one of the models. The wind pressure on the model causes it to be forced back; and this movement is communicated through the steel arm to a nicely balanced beam, upon which a sliding weight records the amount of pressure on the model.

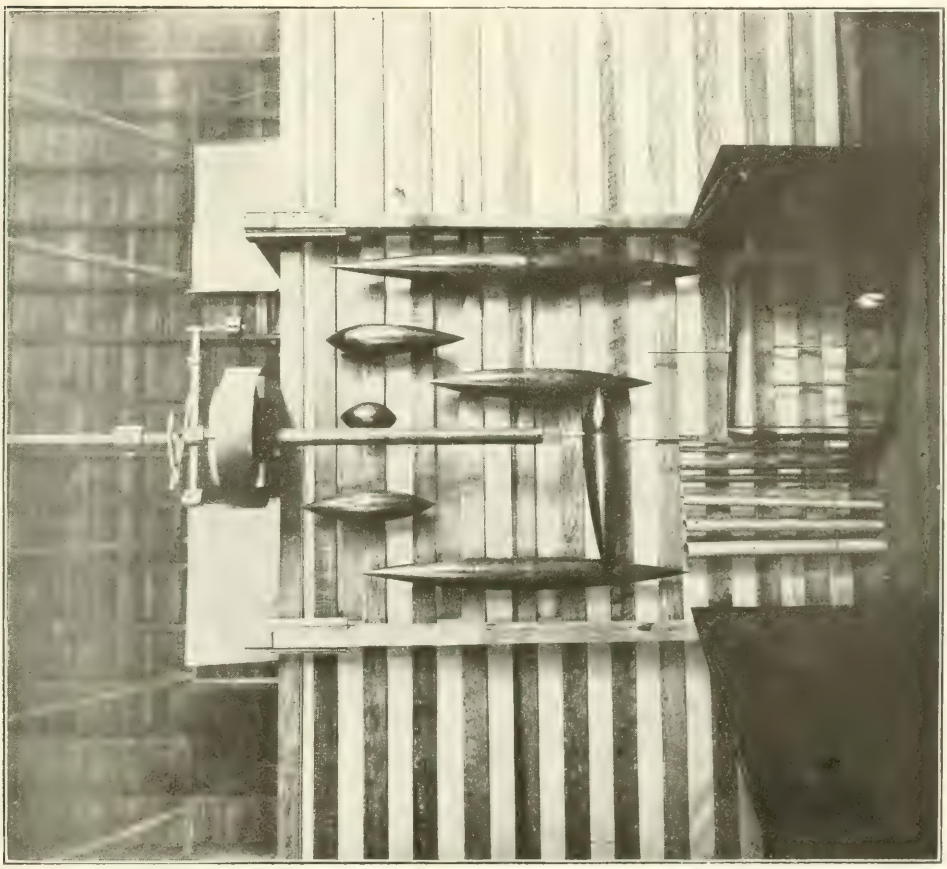
Relations of Shape, Air Resistance, and Skin Friction

The experiments began with a wooden sphere with a highly polished surface. The models were then varied into cigar-shaped bodies, pointed at both ends. These were made longer and sharper for each experiment, but kept at the same diameter in the thickest part.

One of the first things that the experiments in the tunnel did was to upset a long-cherished belief among aëronauts that skin friction of the air on a body

passing through it was practically a negligible quantity. As a matter of fact, the action of air was proved to be almost identical with that of water, roughly speaking, being in direct proportion to the density of the two elements.

The current theory had been that the sharper the cylinder the easier it would cut through the air, and nothing was thought of the skin friction. It was found by experiment in the wind tunnel, that as the sphere was reduced to a sharp-pointed cylinder, the air resistance rapidly diminished to a certain point. Then it rose again as the length of the cylinder was increased. Twelve to one as the proportion between length and diameter, was found to be the shape of least resistance. By shortening the forward section of the cylinder about one-half, and consequently making the end blunter, the air resistance was largely reduced; and, by turning the cylinder around and running its sharp end forward, the air resistance was almost doubled instead of being diminished. This discovery came as a surprise, and completely upset all preconceived ideas about air resistance.



MODELS AND DELICATE WEIGHING MACHINE FOR ASCERTAINING WIND PRESSURE ON VARIOUS BALLOON BODIES.

After many experiments in the tunnel, a shape closely approximating that of a bird, with a comparatively broad, flat breast and a tapering body and tail, was finally decided on as that of least resistance. It will be noted that this is also the shape adopted for the submarine torpedo after much experiment, showing again that air and water offer resistance in practically the same way.

The form of least resistance for rods and supports in airships, has also been

ascertained by experiments in the wind tunnel. The question was presented to the experimenters by designers of flying machines, who suggested sharp-edged rods that would cut through the air. The shape of the rods was found to follow the same law as that of balloon bodies—namely, that the skin friction of the air must be considered in proportioning thickness and sharpness.

The experiments have gone no further than this, work having stopped after the first investigations were completed, but it will soon be resumed.

Future Experiments

Forms of wings for aeroplanes will be one of the next investigations to be taken up, and the tunnel will be utilized to ascertain the lifting power of various shaped wings and the thrust necessary to drive various machines through the air. Different forms of wings, of many sorts of material, used in gliding and soaring machines, have been secured, and will be experimented with in the near future. Dr. Zahm is also anxious to try an experiment with soaring birds. He hopes to induce certain birds to soar under the favorable air conditions in the tunnel. If he succeeds, their performance will be checked with instruments of precision, and more will be learned about bird flight than has ever before been known.

In addition to solving the problem of the size and shape of balloon bodies, Dr. Zahm has established theoretically the economical speed limit for flying machines; and his theory has been confirmed by the Wright brothers, who wrote Dr. Zahm that they had reached the same conclusions in their actual flights. Dr. Zahm's experiments in the wind tunnel established the theory that the air resistance made a speed of forty five or fifty miles an hour the economical limit. Of course, by crowding on more power, the speed can be raised slowly at a great expense of fuel and power. On ocean lines, each quarter-knot added above a speed of twenty knots an hour costs as much fuel as the first ten knots cost altogether. Thus the airship may probably obtain a speed of sixty-five or seventy miles an hour; but the hundred-mile airship is not yet in sight.

Mr. Chanute, the well-known American bridge engineer, one of the most successful exponents of the gliding machine, is keeping in close touch with the experiments at the Catholic University. He has some forms of aëroplanes that probably will be tested during the coming winter. Professor Langley is also much interested in the experiments, and recently sent a check for $500, with a request that the work be continued in the interests of science.

The Uncaring

FULL many keep for those they love
The bitter word, the tear,
And lavish on a careless crowd
Their benison of cheer.
With laughter light for passing guest,
Who soon from them must roam,
They wound the ones they love the best,
And dim the lights of home.

—Lalia Mitchell.

"Which Branch of Engineering Shall I Take Up?"

No. III. Bridge Engineering—An Interview with Ralph Modjeski, Civil Engineer, Chicago

By JOHN L. RAY

RALPH MODJESKI.

Within recent years engineers have specialized along many different lines. The result has been the development of as many practically distinct branches of the profession. Doubtless there are young men, who, having decided that engineering shall be their life work, are hesitating as to which branch they shall take up—Civil, Mining, Mechanical, Hydraulic, Chemical, or any one of a dozen other divisions.

The series of articles under the above head—of which this is the third—is intended to help them come to a wise and discriminating decision. The articles will be based on interviews with eminent engineers, each of whom will set forth the advantages and drawbacks of his own particular specialty. In the present instance, Mr. Ralph Modjeski tells of the situation in bridge engineering. Mr. Modjeski, who is a son of the famous Polish tragedienne, Helena Modjeski, was, for some years, bridge engineer for the Union Pacific Railroad Company. He is now, perhaps, the leading consulting bridge engineer in the country.

"IT is my belief that bridge engineering at the present time is not the most profitable division of engineering for a young man to choose. The supply is greater than the demand."

This is the opinion of Ralph Modjeski, the consulting bridge engineer. It is not a pessimist's view of his own profession. Temporary conditions, he believes, have made the occupation of bridge engineer likely to be less lucrative than other branches of civil engineering. He agrees with Lyman G. Cooley, with whom an interview was printed earlier in this series, that hydraulic engineering presents greater opportunities because of its development into constantly widening fields.

"What I say applies to the general average of young men coming from a technical school," he explained further. "For the exceptionally brilliant there is the same place in bridge engineering that there is in every other profession or occupation. It is the young man without especial predilection for bridge engineering, who, I believe, can find more profit in some other division of civil engineering at the present time—at least until the demand for bridge engineers has caught up with the supply which is being furnished."

These conclusions came at the end of an interview in which Mr. Modjeski sketched some of the details of bridge engineering as it is to-day, treating of the relation which the work of the consulting engineer bears to the shop-produced work now encroaching on the field formerly held exclusively by him.

"Shop work comes more every year to be a factor in bridge engineering," he said. "It might be said now that a railroad company, for instance, can order a bridge as it can order a locomotive. In the latter case it would order a certain tractive power and possibly a certain speed. The gauge, being standard, would be pre-determined.

"In the case of a bridge, the conditions being determined, the order might be filled much as the order for the locomotive was filled. This would depend on conditions. Shop work cannot supplant the work of the consulting engineer entirely, but it is growing more and more to affect his occupation.

"Railroads are adopting the plan of having their own staffs of engineers. The chief engineer has under him his special assistants, one of whom will be

his chief bridge engineer. The latter will supervise the work of the shops; and, unless the case is one of exceptional importance, there may be no place for the special consulting engineer in the whole process of erecting a railroad bridge.

"The same course is likely to be followed in work done for municipalities. The city engineer will supervise the work of the shops, and the bridge will come from the shops, and go up, without the assistance of the special consulting bridge engineer.

"In spite of the facilities which are offered for securing shop-built bridges, the consulting engineer will find his place in work which is not done under the supervision of a staff engineer. I do not mean to intimate that all bridge companies are dishonest, but it will be found that their work has to be watched. There is the inclination to put either too much or too little material in the work—too little if the contract is for a lump sum, and too much if it be otherwise. Unless the corporation buying the bridge have its own engineering department, the consulting engineer will come into the work sooner or later to supervise the plans. If the bridge building be in his hands from the start, his first duties are field duties—to select the site for the structure, if that be not already determined on, to determine the length of the spans, and to build the foundations.

"As an illustration of the difference in conditions which may permit or forbid shop work in bridge building, one may compare the bridging of the Chicago river with the bridging of a stream in the extension of a railroad into practically unopened country. The conditions in the case of bridging of the Chicago river are known; a bridge company, under the supervision of the City Engineer or the Drainage Engineer, can put the structure up. In the latter case, however, the conditions are unknown, and they have to be determined by the consulting engineer in active field work, taking into consideration all the questions of foundation, spans, and assembling."

Mr. Modjeski was asked to what extent invention had an opportunity in bridge engineering.

"Only to a limited extent," he said, "and not to a very profitable one. The patents for "lift" bridges are held by the bridge companies which make a specialty of such work. Occasionally an engineer holds a patent; but in the majority of cases, if invention be necessary to meet some special condition, the engineer does not patent it, but allows it to become public property.

"The patent for the aërial transfer bridge at Duluth is held by a Frenchman. He had erected one before in France, and the conditions at Duluth made it necessary to erect another there. It is not likely that his patent will prove valuable to him in the United States. The necessity for this type of bridge is not apt to be found often enough to make his invention a valuable property."

This Duluth bridge—which is mentioned merely as an illustration of the invention at times necessary in bridge building—is the only one of its kind in America, although there are two in Europe and one in Africa—one across the Seine at Rouen; another at Port Egalité, Spain; and the third at Bizerta, Tunis, the second and third being across arms of the sea.

This aërial bridge, transfer bridge, or ferry, as it may variously be called, is a good example of the product of engineering imagination in action. The necessity of spanning a water thoroughfare—in the case of Duluth, it is a ship channel—without interfering with navigation, and where a draw or lift bridge would not be permitted, is met. The spans rise 185 feet above the water line, and the lowest truss clears the channel by 135 feet. The distance spanned is 381 feet.

Passengers, who at Duluth had been using ferryboats, are now swung across this 381-foot channel in a suspended car which travels twelve feet above the water. This car has a capacity of sixty-five tons, and is timed to cross the channel in one minute and a-half.

The United States War Department had refused to grant permission for the

construction of a drawbridge, and Duluth presented an engineering problem of some dimensions, which was solved by the use of an idea originated by the French engineer in dealing with similar conditions at Rouen.

Mr. Modjeski predicts that, in time, a development of bridge building which has not yet come in this country will change the character of the product.

"We have not reached this stage of development yet," he explained, "although some of our bridges have combined beauty with utility. For the most part we have been satisfied with utility, and reasonably. Take the Chicago river bridges. They certainly are not ornamental; but consider how out of place an ornamental bridge would be in their surroundings.

"The first necessity is to ornament and beautify the surroundings, and then you can have ornamental bridges. In the case of the Chicago river it will be generations at least, before the river-front conditions are radically changed. For that reason the new bridges which have been erected have been designed simply to meet the utilitarian needs of a heavy traffic.

"At Rush street, there is a possibility of improvement in surroundings, and the proposed plans for a new bridge at that point have recognized this by providing for ornamentation.

"This development will come slowly in American bridge building, until finally we shall be building as the Europeans build—with a view to beauty as well as utility. To some extent this will have its effect on the profession of bridge building. The bridge engineer will be required, not only to meet the engineering requirements and solve the engineering problems, but he will have to create a work of art in bridge architecture.

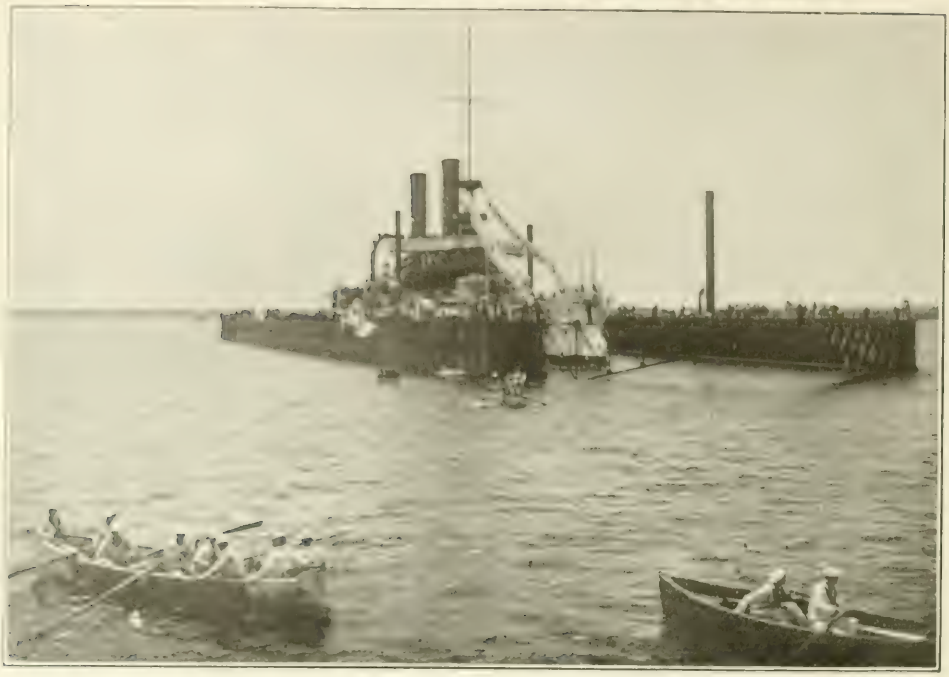
"For the present, however, I believe that a young engineer will do best to turn his attention to some other branch of engineering. Hydraulic engineering offers great opportunities in connection with irrigation, sanitation, water supply, and waterway development. This and other branches of civil engineering are progressing and developing. Bridge engineering is not, to any material extent."

The Farmer's Blessings

NONE can describe the sweets of country life
But those blest men that do enjoy and taste them.
Plain husbandmen, tho' far below our pitch
Of fortune plac'd, enjoy a wealth above us,
To whom the earth with true and bounteous justice,
Free from war's cares, returns an easy food;
They breathe the fresh and uncorrupted air,
And by clear brooks enjoy untroubled sleeps,
Their state is fearless and secure, enrich'd
With several blessings, such as greatest kings
Might in true justice envy, and themselves
Would count too happy, if they truly knew them.

—F. MAY.

NEW U. S. NAVAL FLOATING DRY-DOCK *DEWEY* LIFTING A BATTLESHIP.



Floating Dry-Dock "Dewey"

The Greatest Structure of its Kind——Built for the Philippine Station and Towed across the Pacific

By WALDON FAWCETT

ERE this reaches the eyes of readers, the new United States naval dry-dock *Dewey*—the largest floating dry-dock ever constructed—will probably be well started on its journey to the Philippines. This journey half around the globe constitutes very much the longest transfer ever undertaken in the case of any floating dock. The British Admiralty had a floating dock towed from England to Bermuda some years ago; and the Spanish Government sent across the Atlantic the Havana dock, the possession of which caused controversy after the conclusion of the Spanish-American war; but not only is Uncle Sam's new dock much larger than either of those mentioned, but the distance to be traversed ere it reaches its destination at our new naval station at Olongapo in the Philippines is three times as great as that covered by either of the foreign-built docks above referred to.

By the shortest possible route, the distance from Chesapeake Bay to the Philippines is upward of 11,000 miles; and, if the big dock is on hand ready for use at her station in the Orient by the end of April, 1906, the governmental authorities will be entirely satisfied. The towing of floating dry-docks to points of delivery—including the movement of the lately constructed Algiers dock from the plant of the Maryland Steel Company at Sparrows Point, Md., to New Orleans—has usually been entrusted to private towing companies; but owing to the lim-

ited appropriation available, the Navy Department was forced to undertake the present task, detailing several of our most powerful colliers for the work.

During the autumn of 1905 the new dock was subjected to a series of very thorough tests. The initial tests were made with the armored cruiser *Colorado*, which had at the time a displacement of 13,300 tons distributed over a length of about 500 feet. The time occupied in lifting this vessel clear of the water was 2 hours 16 minutes. Tests which were in some respects even more severe in their exactions upon the dock, were made with the aid of the battleship *Iowa*, which has a displacement of 11,600 tons and a length on keel-blocks of 330 feet. The *Iowa* was lifted out of the water in only 1 hour 37 minutes; and then the pumping continued until, after a total elapsed interval of 2 hours 42 minutes, the freeboard presented was equivalent, as evidence of power expended, to the raising of a 16,000-ton vessel. The *Dewey* was self-docked in a period of fifteen days; and it is believed that with more experience the time can be reduced to ten or eleven days, or possibly even less.

The Navy Department contract for the new dock called for a capacity to lift 16,000 tons, with a freeboard of two feet; but as a matter of fact, the *Dewey* can lift 18,500 tons, with this freeboard. This is 1,000 tons in excess of the capacity of the Algiers dock constructed by the same builders, the Maryland Steel Company, and is far in excess of the capabilities of all the other large floating dry-docks in the world. For instance, the Bermuda dock has a lifting capacity of only 16,000 tons; and the Stettin dock, which attracted so much attention when it was built in Germany a few years since, has a capacity of only 11,000 tons.

The *Dewey* has cost the United States Government more than $1,125,000; and a considerable expenditure will, of course, be added to this sum ere the ponderous craft is installed at its permanent station beyond the Pacific. More than 11,000 tons of steel and 2,000,000 rivets were used in the construction of the dock, and accommodations are provided on board for nine officers and twelve men. At light draft, the dock draws only a little more than six feet of water; but she requires a depth of more than fifty feet of water in order to enable her to handle the largest and heaviest class of warships.

The Strenuous Life

"I WISH to preach, not the doctrine of ignoble ease, but the doctrine of the strenuous life—the life of toil and effort, of labor and strife; to preach that highest form of success which comes, not to the man who desires mere easy peace, but to the man who does not shrink from danger, from hardship, or from bitter toil, and who out of these wins the splendid ultimate triumph."

—THEODORE ROOSEVELT.

The Wireless Death

By C. S. Raymond

I

IN the early morning, the crowds which spent most of the night at the bulletin-board were gathering again. At no time had the place been entirely deserted. Several men had never been out of eyeshot of the bulletins. One of them, a shock-headed youth in overalls and wearing the cap of a government electrician, sat on the stone curbing by the entrance to the power station, smoking a small black pipe, seemingly more occupied with meditation than observation.

Most of the men who now were gathering about the board, were coal miners on their way to the shafts. Here and there were electricians. The vastness of the power station from which they had come, was no more than suggested from where the crowd stood, the buildings being partially hidden in a grove of trees.

The groups of miners and electricians were almost silent. They seemed to have exhausted comment and surmise, and to be waiting for the tangible to take the place of conjecture.

On the Verge of War

In Washington the federal news editor apparently had worn out himself and his staff in keeping up a detailed account of the all-night session of Congress. As daylight came, the service wabbled, and what had been a connected, well-sustained story of congressional proceedings had slumped to a series of jerky bulletins of which the last had come a half-hour before, reading:

"Williams still has the floor. He is making no headway against the majority. War seems inevitable."

To the men starting for the shafts, this carried no news which they had not known before they had gone away, a few hours earlier, to get such sleep and rest as they could.

While they stood watching, another bulletin came:

"Congress has taken an hour's recess for breakfast. No action."

The coal miners in the crowds read this, and then started for work. Soon there were left only a few scattered groups; but the shock-headed electrician still sat on the curb and smoked his black pipe.

Mail by Airship

A speck developed in the eastern sky and grew nearer, enlarging rapidly. Then the Washington mail came into sight, and landed at the aëroplane station near the entrance to the power station. A mail clerk came down the elevator after the mail sacks had been thrown into the chute. He was questioned eagerly by the men still standing about the bulletin-board, but had nothing of news later than that which the bulletins had given them.

As he stood talking, another message was flashed on the board:

"Williams says that opposition to the majority will cease. War will be declared before night."

At that the shock-headed youth arose suddenly from the curbstone, and walked rapidly through the gates and on into the grounds of the power station.

Vast Central Power Station

The Susquehanna Coal and Power District, supplying not only Washington but New York with electric power for all purposes of light, heat, and power, was the largest of the government power areas into which the country was divided. Its coal mines were of the greatest extent, its power station gigantic, and its employees an army. New York, with its millions, and Washington with its institutions, secured all power from the wires charged by the dynamos of the Susquehanna District.

The shock-headed electrician kept his rapid stride through the grounds until he came to a one-story brick building marked, over its doorway, with the word "Administration." It was surrounded by beds of sweat peas, which a gardener then was watering. The young man went up the graveled walk without looking to right or left, pushed open the door, went the length of the inner hall, turned to the right, and knocked at a closed door.

He was told to enter, and did so, taking off his cap.

A middle-aged, gray-haired, spectacled man sat at a desk in the center of the room. He did not look up until the young electrician was standing beside his desk. Then he glanced at him sidewise inquiringly.

Young Inventor Busy

"Mr. Shod," said the younger man. "I want a two weeks' leave of absence."

The elder then looked squarely at him but did not reply, merely brushing back his hair in an abstracted, preoccupied manner. The young man waited for an answer without repeating his petition.

"Go back to work," said Shod, finally, seeming to dismiss the request as preposterous. He had started to speak calmly, but his manner changed, and he brought his fist down on the desk as he added sharply:

"Atsins, you make me think you crazy. Haven't you read the bulletins? Look here. A message from the chief. 'We expect you to run double capacity from the instant war is declared.' —Leave of absence! Man, go back to work!"

Atsins grew confused and awkwardly abashed; but he persisted, nevertheless, urging great necessity.

"If you even ask again," cried Shod, becoming thoroughly angry, "I'll have you locked up for attempted desertion."

Daring Plan Explained

He wheeled around in his chair, and busied himself with the wires leading off the keyboard on his desk. Atsins hesitated an instant, and then suddenly lost his awkardness and became alert. He bent over his senior, and spoke rapidly, energetically, and sharply. He drew from the inner pocket of his blouse a print, and spread it before Shod. The anger of the older man gave way to astonishment. He was held spellbound by the younger's vehement explanation, until finally Atsins ceased talking, folded up his print, returned it to his pocket, and stood waiting.

Shod contemplated him silently for several moments. Then he said:

"You have a chance. It is too great a chance to lose. It might be our salvation. I'll inform the chief."

He reached over toward the keyboard; but Atsins put out a restraining hand and held him, shaking his head in vigorous protest.

"Well, I guess you are right there, too," the older man said; "do as you think best."

Catches Airship for Capital

Mesus turned away instantly, and again with rapid stride went through the grounds. On looking at his watch, he broke into a run, heading for the aëroplane station. By quick sprinting he reached the lift just as it was making its last trip up to connect with the fast Washington mail ship. It touched as he came out on the platform, and he was aboard just in time.

TWO AIDS WERE BUSY WITH THE REFLECTOR.

II

In the early history of the nation there had been a much applauded maxim: "In time of peace, prepare for war." The people had never deviated from their policy of applauding and ignoring this wisdom of one of their earliest statesmen. The nation had never lost its complacency. It had never succeeded in disillusioning itself. It imagined itself peaceful. In reality, it was quickest to resent an injury, fancied or real, surest to raise a popular demand for war, and least prepared to carry it on.

Nation in a Trance

With the self-deceiving theory that they were not a militant people, they had continued to delude themselves in the belief that war for them was next to impossible. Their history, a record of conflicts made costly because undertaken without preparation, did not serve to destroy this illusion. It was a part of the national life.

Now popular outcry was forcing another war. At any moment, Congress, which had been in the throes of debate for three days, might open hostilities with a declaration.

Across the Atlantic, as the military men of the nation knew, a martial people were holding themselves in restraint, confident in their ability founded on thorough preparation. The nation in general knew this, but it allowed itself no thought of the inevitable product of incompetence urged into action by rashness.

In all this unprepared country, no one appreciated so thoroughly the impending danger as did Montrus, the unfortunate commander-in-chief of the small military forces.

Commander in Despair

He had been dean of the department of electricity in the national university, when transferred to the military service, having, prior to this, been an instructor in one of the national military schools. In

appearance he was scholastic, his figure spare and bent, his hair and eyes grey, and his face thin-jowled.

He was alone in his office, looking out of a window across the Potomac—the only inactive figure in the War Department—when one of his aids entered the room.

"Curts has been located," said the aid. "He is at Kiel. We got his signal, followed by some code which is being transscribed."

Another aid came in.

"Curts says he is effectually hidden, and can send electrographs if we can take them."

"Where is he?" asked Montrus eagerly.

Scouting the Upper Air

"He says he is out of the path of their scouts, and thinks he is safely posted. He must be above them."

"Can you reach him?"

"We have, but he warns us not to try often. I suppose his position is precarious at best."

"Tell him to send what he can," answered Montrus. "I'll go into the tower to take it."

A hundred yards farther up the Potomac, stood a gigantic tower, the exact longitude and latitude of which was burned in the memory of every operative in the secret service. To this, Montrus and his aids hastened, being carried directly to the summit by a lift.

While the aids adjusted the films and reflector of the electro-photographer, Montrus stood at the railing looking out over the peaceful river scene and drumming his fingers on the wooden bars.

"I think it is coming," said one of the aids finally; and the general stepped over to adjust about his head the hood which shut all light from the eyes looking at the reflector.

Looking Across the Ocean

At first this remained in black and inky darkness. Then came little waves of dim light which rippled across its surface. These ripples became stronger; and indistinct shapes, unrecognizable and mystic, seemed to rise out of its depths. They cleared away, and there grew up in their place the forms of a city's roofs and towers, which stood revealed in distinct outlines for a moment and then seemed to drop further and further down into the reflector.

White, fleecy clouds came between the eye and the city's roofs, the latter growing less and less distinct. There was a sweep of a dark object athwart the clouds. It crossed the entire reflector, and blotted it out in blackness again, but light followed almost instantly. Again nothing but the white clouds, but finally a far-off flock of specks, which came nearer and nearer until they stood out each distinctly and separately, clear-cut in outline and identity. There they stood.

Aërial Torpedo-Boats

Montrus almost held his breath as he ran his eyes over them. For ten minutes he studied. Then he drew the hood from his head, and looked out over the river scene again.

"A hundred, I should say," he remarked at last, quietly, but in great bitterness. "Every one ready. In twenty-four hours from the time those awful fools in Congress declare war, those hundred torpedo ships will be here. Tell Curts we've seen enough."

With that he went back to his office, and in moodiness took his post by the window again. Nothing he could plan could avert the calamity he had seen in readiness. Presently one of the aids came in again.

"A government electrician is outside," he announced. "He insists on seeing you. We have done everything to get rid of him but throw him off the grounds."

The man stopped and waited expectantly.

"Tell him—" said Montrus angrily, but stopped. "Let him in," he concluded, sullenly.

Young Inventor to Rescue

The aid went out, and came back with the shock-headed electrician who had spent the night before by the bulletin-board. His embarrassment was great, but his earnestness equaled it. The former showed in his awkward posture and

twitching fingers; the latter, in the direct look with which he sought the general's eyes.

"Well," exclaimed Montrus, sharply.

"I have a concentrator—I want you to look at it—I thought—"

He began excitedlly, and ended brokenly in the face of a cold stare from Montrus.

"Here it is," he concluded, unfolding the prints.

Montrus cast one careless and a second interested glance at the plans. He drew up a chair and studied them, the moodiness giving way to keen appreciation. Then he pushed them away.

"You seem to have something," he said. "Some other time, if there's anything left of this country, some other time I'll look at them. But not now. I can't now."

Death to Distant Fleet

"But you don't understand," exclaimed Atsins, quickly and vehemently. "Now's the time. Don't you see. That will direct a million volts—two million volts—accurately, to any distance, at any object! Man! if it works, if it will do it! Don't you see?"

Montrus stared at the shock-headed boy in a daze.

Atsins held himself in check and leaned forward.

"Will the ships at Kiel ever leave their moorings if it works?" he asked, drawing in his breath sharply. The two men looked at each other; and, as Montrus stared, he saw also in his mental vision those hundred dark shapes on the face of the reflector.

Then he pressed a series of buttons on his desk, and men entered from different doors.

"Take this young man, Mr. —?"

"Not a name," said Atsins. "Just an idea."

Making Ready for the Trial

"Take this idea," continued Montrus, speaking rapidly, "to Sending Station 10, the largest. Let him direct any changes he desires. Tell Susquehanna to give us ten times the usual power from now until notified otherwise."

The men started to obey, and Atsins to follow his guides, when Montrus stepped to him, holding out his hands.

"I hope you succeed," he said.

"I—I can't fail," stammered the young man.

III

To the surprise of the nation, Congress held back during the day, a narrow fringe of conservative members standing between the country and war. The news service, which had picked up again and was voluminous and detailed once more, still carried the prediction that war was inevitable and could be only delayed.

Meanwhile the stolid hopelessness at the War Department, which had blanketed even the energetic efforts of department chiefs to do the best they could at the eleventh hour, had given way to a feverish activity extending even to departments unaware of the purpose.

Atsins had taken a fast express ship back to Susquehanna, returning at top speed with the concentrator, the plans of which he had shown Shod and Montrus, and which, many months before, he had constructed.

Shod had his orders regarding power, orders which carried a significance to him but to none other at the power station.

Giant Concentrator Set up

At No. 10 Sending Station, Atsins, with an army of electricians and mechanics under him, worked at nerve-racking speed during the day. Montrus, possessed by a devil of impatience, foreboding, and fear, could not contain himself either in the office or at the station.

The work progressed; the concentrator went into place; reinforcement was added to every detail of the station; its capacity was increased to the limits of possibility. Night had come and was advancing. Still Congress held to its weary debate. Ten o'clock came; and Atsins sought Montrus, finding him nervously pacing back and forth in his office. The young electrician was calm and charged with quiet confidence.

"If we can get their location, they will not leave," he said. "Maybe you cannot furnish it?"

"We can if we can get Curts again," said Montrus. "What if we can't?"

IT REVEALED A TORN AND SHATTERED FLEET.

"Then we shall have to take them when we get it," replied Atsins. "It would be safer to get them before they start."

Aërial Scout is Missing

"Try for Curts again," ordered the general, turning to the aid in the room. They waited for an answer, which came back presently. The operator at the Sending Station No. 5 reported that his efforts were not successful, and he advised against many repetitions.

"It endangers him," he said. "He will report when he can."

With nothing to do but wait, in nervous tension, they saw the hours mount to 12. Then came a bulletin from Congress. The vote was about to be taken. Of the result there could be no doubt, and there was none in the minds of the men sitting in the office. There had been none from the start; and yet, now that the moment had come, they looked at each other, pale-faced and heavy-eyed.

"Come outside," said Montrus to Atsins. "We'll feel better in the open."

Before they could step out of the door, a messenger came in.

"Curts reports," he said. "The fleet has left Kiel. He will send location."

Aërial Fleet Leaves Kiel

"Tell Curts," said Montrus, speaking low-voiced, "that the outcome of this war depends on him. We want the location. We must have it. If he can send electrographs, send them; but first the location."

With Atsins, he walked out into the night. The sky was black. The air was heavy and wet. A gentle drizzle was starting.

The two men took a few deep breaths, and then turned to each other. Neither spoke, but each held out his hands. One close grasp, and they parted, Atsins for the sending station, Montrus for the tower.

When the latter stepped off the lift at the top, he found two assistants busy with the reflector. Far away in the drizzle were the lights of Washington and the Capitol. The general glanced at the bulletin, but it told him nothing new. The roll-call was being delayed by members who insisted on explaining their votes, notwithstanding that they and the others had reached the limits of human endurance. He glanced at the other board, which would give him in duplicate any word that might come from Curts. It was blank; but as he looked, it flashed out with:

"52 30 17 N. O 53 34. 9 E."

German Fleet is Located

"We've got it," he almost gasped; and then he turned to the assistants, jerking out his commands:

"Ready there. We ought to get something from Curts in a moment. Let me know when it starts. Tell the Capitol we must have instant notice of the declaration."

At another televue he got Atsins at Sending Station No. 10.

There also they had a duplicate of Curts's message giving the longitude and latitude of the hostile fleet.

"Ready?" asked the general.

"Ready," said the electrician.

Montrus enveloped his head in the hood at the reflector—hardly a necessity, so black was the night. Across the Atlantic, day had broken, and Curts had the light he needed in his electro-photography and transmission. Somewhere above the hostile fleet, Montrus knew, the scout hung precariously in a position to send not only information but a continuous reflection of the movements of the airships. He might be discovered, but that was the hazard of his occupation. If he were well concealed by distance, and out of the path of the enemies' scouts, he would win out. If otherwise, he at least had done his duty to the best of his ability.

Waiting for War

With one finger on a button which would give the signal to Atsins, the general waited word from the Capitol. Sixty seconds after the vote had been taken and war declared, the world would know it. The hostile fleet would know it almost as soon as Montrus. It was in the arrogance of superior force that the enemy had waited the formal beginning of hostilities.

Ripples of light were chasing each other again across the reflector; shadowy forms appeared and disappeared in vapors and fogs. Then came an outline,

growing more distinct, and presently he had the picture again.

Outside the hood was the black, drizzling night; inside, the face of the reflector was glowing with a picture of clouds lighted by the early rays of the sun and of a fleet of airships languidly floating at rest.

Montrus could see the flags floating from the ships, could see their torpedo-tubes and the graceful movement of one here and there as it changed position slightly.

One of the assistants at his side stooped over and shouted at him through the hood:

"Here's the flash. War's declared!"

Ready for the Wireless Death

The general twitched with suppressed excitement. For a moment longer, he watched the picture in the reflector. Then he saw that the fleet had the news. Across the Atlantic the instantaneous service had carried the declaration of war.

Far below him was the chief city of his nation, now subdued in the knowledge that it and the nation had been brought to the final test. In the sending station was the man on whom his nation's hopes depended. He slowly pressed the button.

In the reflector he saw the enemy's squadron move. He knew that it had been in readiness to start, and on the instant of the receipt of the tidings was setting forth. If it came unmolested, as it had every right to expect it would, there could be but one result to his nation.

It seemed an eternity of time as he watched the reflector.

Great Fleet is Blotted Out

Suddenly one of the ships disappeared in a blotch which sent confused shadows over the reflector. Montrus trembled in his excitement. The picture grew clear for an instant. Then another blur—a quick succession of blurs, between which he could see nothing.

He grew dizzy, and held tightly to the supports of the reflector to steady himself. His unblinking eyes were so held by the grim, silent chaos of destruction portrayed before him, that the seeing faculty seemed a thing apart from him and separated completely by his dazed condition.

The tumultuous heaving and blurring on the reflector cleared away. It revealed a torn and shattered fleet—two-thirds of the ships vanished completely, others beating feebly and in their last efforts, others slowly sinking through the air, a few trying to escape from an unseen terror.

Gen. Montrus, veteran though he was, shuddered at the horror of the sight. Unseen, unheard, softly through the thick darkness, the wireless death had swept that proud aërial fleet out of existence in one tense instant. And Atsins, the shock-headed youth, was the destroyer, sitting calmly up there in the sending station, with one soiled hand on the lever of his great concentrator. It was he who had utilized the means formerly used to send messages, to bear intelligence across boundless areas, which, increased a hundred thousand-fold in voltage, controlled, concentrated, and directed, had carried also absolute destruction.

Nation is Saved

Still breathing heavily, Montrus threw off the hood, coming back to the utter blackness and the drizzle of the Washington night.

A bulletin was flashed on the board which carried the duplicates from Curts.

"Fleet gone—Vanished in Convulsion—Pictures Actual and Accurate—Disturbance not caused by defects but by destruction of fleet—Can't explain it, but we are saved!"

Montrus turned the wireless televue onto the sending station, and saw Atsins sitting quietly on a box in one corner of the little room, his shock of blonde hair badly rumpled, a smile on his freckled face. "Atsins"—the commander-in-chief was trying hard to control his voice—"Atsins! You have saved us! It is all over! Their fleet is annihilated!"

It seemed to the old soldier, veteran of a dozen campaigns, absurdly impossible that the safety of a great nation should have been put into the hands of that grimy boy in blue overalls.

"It worked all right, didn't it!" Atsins answered calmly.

"Come over here," Montrus went on. "Hurry and come. Tomorrow Congress 'll be giving you a vote of thanks; you'll be a bigger man than old Dewey ever was!"

A troubled frown came on Atsins's face. "Cut that rot out, please," he said. "I'm going back to work. I've just thought of a big improvement on my concentrator. Good night!"

Folded Hands

DEAR folded hands, so worn with care,
So quiet on the pulseless breast,
Will any burden need you there,
If heaven is a place of rest?
And you, dear heart, will you forget
The struggles of these lower lands?
Or is there some sweet service yet,
For folded hands?

Yours was the never-ending task,
Born of a never-ending need;
Our selfishness it was to ask,
Your sweet unselfishness to heed.
And now, in the unwonted rest
Long promised, in the better lands,
How can you sit, an idle guest,
With folded hands?

No tears to dry, no wounds to bind,
No sufferer to tend and bless—
Where will those eager fingers find
A need for all their tenderness?
Yet, knowing all they did before,
Perchance the Father understands,
And holds some precious work in store
For folded hands.

—Ola Moore.

Furnace System of Warming

A Discussion of Some of the Principles upon which the Warming of Buildings by Hot Air is Based

By CHARLES L. HUBBARD, S. E., M. E.

WITH the exception of the stove, the hot-air furnace is the most economical of all heating systems, from the standpoint of cost of installation; and it is also the simplest in operation. In this method, the air is drawn over heated surfaces, and then transmitted through pipes, while at a high temperature, to the rooms where heat is required. Furnaces are used largely for warming dwelling-houses, also churches, halls, and schoolhouses of small sizes. They are more costly than stoves, but have some advantages over that form of heating. They require less care, as several rooms may be warmed from a single furnace; and, being placed in the basement, all dust from coal and ashes is kept from the rooms above.

The Construction of a Furnace

In construction, a furnace is a large stove with a combustion chamber of ample size over the fire; the whole being enclosed in a casing of sheet iron or brick. The bottom of the casing is provided with a cold-air inlet, and at the top are pipes which connect with registers placed in the various rooms to be heated. Cold, fresh air is brought from out of doors through a pipe or duct called the "cold-air box;" this air enters the space between the casing and the furnace near the bottom, and, in passing over the hot surfaces of the fire-pot and combustion chamber, becomes heated. It then rises through the warm-air pipes at the top of the casing, and is discharged through the registers into the rooms above.

As the warm air is taken from the top of the furnace, cold air flows in through the cold-air box to take its place. The air for heating the rooms does not enter the combustion chamber.

Fig. 1 shows the general arrangement of a furnace, with its connecting pipes. The cold-air inlet is seen at the bottom, and the hot-air pipes at the top; these are all provided with dampers for shutting off or regulating the amount of air flowing through them. The feed door or fire door is shown at the front, and the ash door beneath it. Inside the casing is placed a water pan, which furnishes moisture to the warm air before passing into the rooms. Water is either poured into the pan through an opening in the front, provided for this purpose, or is supplied automatically through a pipe.

The fire is regulated by means of a draft slide in the ash door and a cold-air or regulating damper placed in the smoke-pipe. Clean-out doors are placed at different points in the casing, for the removal of ashes and soot. Furnaces are made of either cast iron or wrought iron plates riveted together and provided with brick-lined fire-pots.

One great advantage in this method of warming comes from the constant supply of fresh air which is required to bring the heat into the rooms. While this is greatly to be desired from a sanitary standpoint, it requires a larger amount of fuel than would otherwise be necessary, for, in addition to the heat lost by leakage through walls and windows, heat is required to warm the fresh air from out of doors up to the temperature of the rooms.

A more even temperature may be maintained in this way than by the use of stoves, owing to the greater depth and size of the fire, which causes it to be more easily controlled. When a building is placed in an exposed location, difficulty may be experienced at times in warming certain rooms, depending upon the direc-

tion of the wind; this may be overcome to a large extent by a proper location of the furnace and the exercise of suitable care in running the connecting pipes.

Location of Furnace

A furnace should be so placed that the warm-air pipes will be of nearly the same length. The air travels most readily through pipes leading toward the sheltered side of the house and to the upper rooms. Therefore pipes leading toward the north or west or to rooms

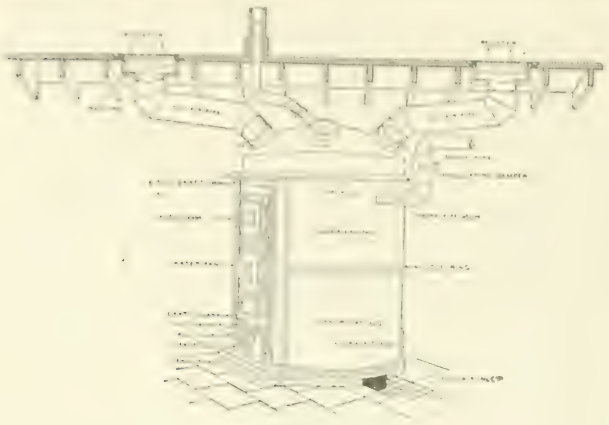


FIG. 1.

on the first floor, should be favored in regard to length and size. The furnace should be placed somewhat to the north or west of the center of the house or toward the points of the compass from which the prevailing winds blow.

Cold-Air Box

The cold-air box should be large enough to supply a volume of air sufficient to fill all the hot-air pipes at the same time. If the supply is too small, the distribution is sure to be unequal, and the cellar will become overheated from lack of air to carry away the heat generated.

If a box is made too small, or is throttled down so that the volume of air entering the furnace is not large enough to fill all the pipes, it will be found that those leading to the less exposed side of the house or to the upper rooms will take the entire supply, and that additional air to supply the deficiency will be drawn down through registers in rooms less favorably situated. It is common practice to make the area of the cold-air box three-fourths the combined area of the hot-air pipes. The inlet should be placed where the prevailing cold winds will blow into it; this is commonly on the north or west side of the house. If it is placed on the side away from the wind, warm air from the furnace is likely to be drawn out through the cold-air box.

Whatever may be the location of the entrance to the cold-air box, changes in the direction of the wind may take place which will bring the inlet on the wrong side of the house. To prevent the possibility of such changes affecting the action of the furnace, the cold-air box is sometimes extended through the house and left open at both ends, with check-dampers arranged to prevent back drafts. These checks should be placed some distance from the entrance, to prevent their becoming clogged with snow or sleet. The cold-air box is generally made of matched boards, but galvanized iron is much better. The latter costs more than wood, but is well worth the extra expense, on account of tightness, which keeps the dust and ashes from being drawn into the furnace casing to be discharged through the registers into the rooms above.

The cold-air inlet should be covered with galvanized-wire netting with a mesh of at least three-eighths of an inch. The frame to which it is attached should not be smaller than the inside dimensions of the cold-air box. A door to admit air from the cellar to the cold-air box, is generally provided. As a rule, air should be taken from this source only when the house is temporarily unoccupied or during high winds.

Return Duct

In some cases it is desirable to return air to the furnace from the rooms above, to be reheated. Ducts for this purpose are common in places where the winter temperature is frequently below zero. Return ducts when used, should be in

addition to the regular cold-air box. Fig. 2 shows a common method of making the connection between the two. By proper adjustment of the swinging damper, the air can be taken either from out of doors or through the register from

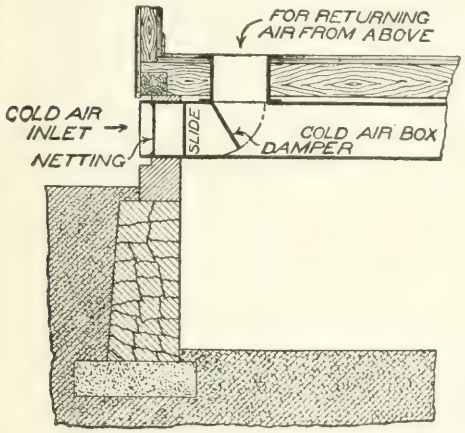


FIG. 2.

the room above. The return register is often placed in the hallway of a house so that it will take the cold air which rushes in when the door is opened, and also that which may leak in around it while closed. Check-valves or flaps of light gossamer or woolen cloth should be placed between the cold-air box and the registers, to prevent back drafts during winds.

The return duct should not be used too freely at the expense of outdoor air; and its use is not recommended, except during the night, when air is admitted to the sleeping rooms through open windows.

Warm-Air Pipes

The required size of the warm-air pipe to any given room, depends upon the heat loss from the room and the volume of warm air required to offset this loss. Each cubic foot of air warmed from zero to 140° brings into a room 2.2 British thermal units (B. T. U.). In zero weather, with the air entering the registers at 140 degrees, only one-half of the heat contained in the air is available for offsetting the losses by radiation and conduction, so that only 1.1 B. T. U. in each cubic foot of entering air can be utilized for warming purposes. Therefore, if we divide the computed heat loss in B. T. U. from a room, by 1.1, it will give the number of cubic feet of air at 140 degrees necessary to warm the room in zero weather.

As the outside temperature becomes colder, the quantity of heat brought in per cubic foot of air increases; but the proportion available for warming purposes becomes less at nearly the same rate, so that, for all practical purposes, we may use the figure 1.1 for all usual conditions. In calculating the size of pipe required, we may assume maximum velocities of 280 and 400 feet per minute for rooms on the first and second floors respectively. Knowing the number of cubic feet of air per minute to be delivered, we can divide it by the velocity, which will give us the required area of the pipe in square feet.

The Honor Roll

IT is not always the doing well
That measures the fame of a man;
The hero is he who the world can see
Is doing the best that he can.

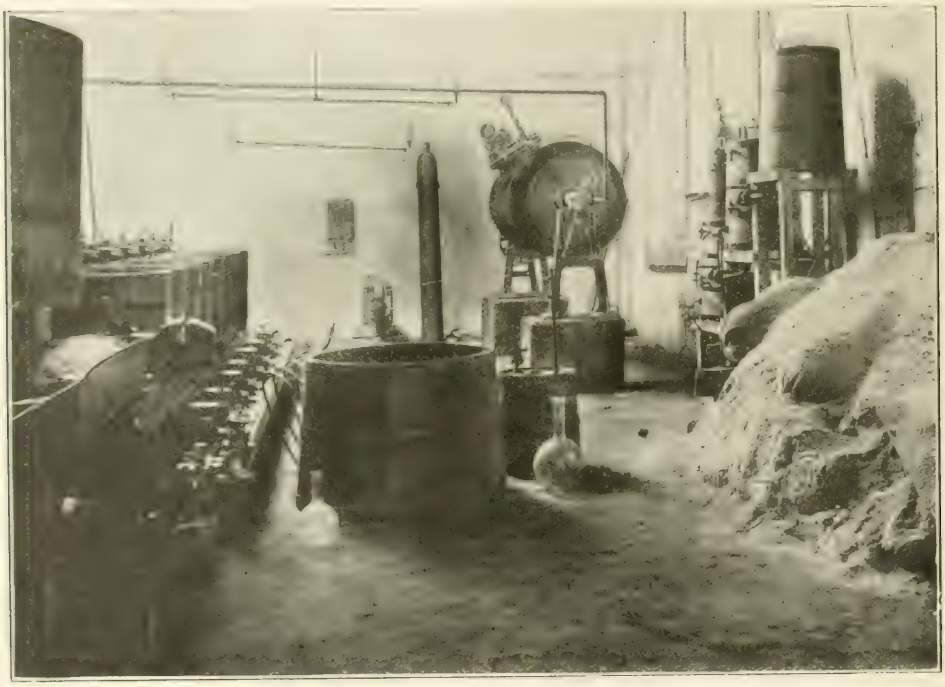
Make Alcohol From Sawdust

Simple German Method which has Proved Commercially Practicable and Profitable

By JOHN C. JENKINS

PROF. ALEXANDER CLASSEN of the technical college at Aix-la-Chapelle, Germany, has worked out a thoroughly practicable and commercially successful method of making alcohol from sawdust. It differs from the process formerly exploited, in that to convert the cellulose into glucose, gaseous sulphurous acid is utilized, instead of sulphuric acid, which it is difficult and costly to remove.

The first illustration shows the stills and apparatus used in the manufacture of the sulphurous acid, and also, in the rear, to the right, the "digester," in which the sawdust is treated. The digester is a revolving iron drum, lined with lead, which is necessary to resist the action of the acid. The charge of sawdust is put into this drum, and is mixed with one-third its weight of the acid solution. The drum is then revolved, its jacket being meanwhile filled with steam which raises the charge to a temperature of 295° F. The heat causes the sulphurous acid gas to act on the cellulose of the sawdust, glucose being formed. Three hours are required to complete the process, during which time the pressure of the expanding gases rises to over 100 pounds per square inch. The excess steam and sulphurous gas then pass together into absorbing



AIX-LA-CHAPELLE APPARATUS AND STILLS FOR PREPARING SULPHUROUS ACID.

Showing also in the rear right-hand corner the digester for converting the cellulose of sawdust into sugar or glucose.

ALCOHOL STILLS AND EXHAUSTER FOR EXTRACTING SUGAR FORMED IN DIGESTER.

tanks, and are thus saved to be used again later. The digester now no longer contains sawdust, but simply wood fiber and glucose or sugar together with a few other minor products formed by the action of the heat and acid as well as by the pressure. The sugar, with the sawdust fiber, goes into exhaustion tanks; and the sugar, of which about 85 per cent is fermentable, is washed out. The water passes through these exhaustion tanks continuously, washing out the glucose completely, in this experimental plant ten vats being in use for this purpose, with a capacity of 36 gallons each. They are connected by valves and pipes in such a way that the contents of any one tub can be emptied into any other; and when the contents of one vat have been treated with ten washings, that vat is emptied and refilled.

A long ton of sawdust produces a solution containing about 500 pounds of sugar, of which about 75 or 80 per cent is fermentable, when treated with yeast, the remaining portion being non-fermentable.

The next process takes place in the "neutralizing" tank, where the solution from the exhaustion vats is neutralized with calcium carbonate. If this were not done, the sulphurous acid which might be carried over, or any organic acid which is formed, would destroy the yeast in the next step in the manufacture of alcohol.

This next step is fermentation. The solution is kept at a constant temperature and yeast is added, fermentation taking place very quickly. The process from this step on is similar to that which takes place in distilleries, the solution passing from the fermenting vats to the stills.

A remarkable feature of this process is the fact that the sawdust after leaving the exhaustion vats, can be used for fuel; for, although its volume constantly diminishes after each step in the process, still its value as a fuel remains unchanged, no component having a fuel value having been removed.

The process is constantly being improved, and about 25 gallons of absolute alcohol is now obtained from a long ton of sawdust, or about double that quantity of crude alcohol.

Invitation to Readers

THE TECHNICAL WORLD MAGAZINE is published for the information, as well as for the entertainment, of its readers. Primarily its purpose is to be helpful, rather than merely interesting.

Are you puzzled by any question in engineering or the mechanic arts? State your problem in writing, and mail it to the Consulting Department of THE TECHNICAL WORLD MAGAZINE. It will be answered as speedily as possible by an expert especially familiar with the questions involved. For the purpose of having this work done thoroughly and in an authoritative way, THE TECHNICAL WORLD MAGAZINE has made arrangements with the American School of Correspondence at Armour Institute of Technology to have all problems of a technical nature submitted by its readers answered by the members of the school's staff of professors and instructors.

If the question asked or the problem presented is of general interest, the solution will be printed in the columns of the magazine. If of merely personal interest, it will be forwarded by mail, provided an addressed and stamped envelope is enclosed for the purpose when the question is sent in.

Load on Journal Bearing

Question: What is the safe load in pounds that can be placed on a solid journal bearing with ten rollers?—*P. R. T.*

Answer: Such a problem is to be solved by multiplying the length of one roller in inches by the number of rollers. Divide the result by three times the linear velocity of convex bearing surface to concave bearing surface in feet per minute. Multiply this result by 100,000 times the square of the diameter of the roller in inches. This is the method to use, but we cannot answer your problem, as you have failed to give sufficient data, the length of rollers, diameter, and velocity not being given.

Reaction of Motor and Generator

Question: We have a 14-horse-power compound-wound multipolar dynamo running a motor of the same type, the motor being connected in parallel with the generator. The other day, after I had just shut the steam off from the engine, the fuse blew on the motor line. After I had replaced the fuse and started the dynamo, the motor ran all right, but the voltmeter and ammeter showed no signs of current. After stopping the dynamo and starting it again, the pilot light burned and the voltmeter and ammeter seemed to be reversed. As everything else was apparently all right, I crossed the wires to the meters and they worked all right. What was the cause of this action?—*J. H. B.*

Answer: The reason for the above-mentioned action is probably that you stopped the generator too quickly—without cutting out the motor. The generator then slowed down quite suddenly; and the motor, kept on, operating as a generator, owing to the inertia of the load which it was carrying. It thus sent current through the series winding of the dynamo, reversing the polarity. The reason that the fuse blew is because the

dynamo practically formed a short circuit upon the motor, causing an excessive current to flow.

Use of Return Trap

Question: When is it necessary to use a return-trap in a hot-water heating system?—*U. C. T.*

Answer: When the steam used in the heating system is at boiler pressure, the condensation may return direct to the boiler by gravity; but if steam at a reduced pressure is used, it must be trapped to the receiver of a return pump, or to the sewer.

Pumping Hot and Cold Water —Boiler Feeding

Question 1: Can hot water as well as cold be pumped with the ordinary steam pump?

Question 2: What piston speed is proper for boiler feeding?—*T. V. McM.*

Answer 1: The only difference is that hot water cannot well be lifted by suction, as its vapors tend to destroy the necessary vacuum. Therefore, when hot water is to be pumped, the pump should be placed below the source of supply so that the water will flow down to it.

Answer 2: For continuous boiler-feeding service, about fifty feet per minute would give best results.

Transforming Current by Rotary Interrupter

Question: Will you please tell me if a direct current can be transformed from a low to a high voltage and current by means of a rotary interrupter. Would such a current do for running a motor or for lighting incandescent lamps?—*C. F.*

Answer: It is, of course, impossible to raise both the voltage and the current at the same time by any sort of apparatus, as here you would be actually increasing the amount of power, or *creating* energy. All you can do with any sort of transformer is to increase voltage at the expense of the current, or *vice versâ*.

As to performing these latter operations in the case of a direct current, we should say that it is possible to do so; but the scheme is not practical for lighting or power purposes, because of the spark at the interrupter. A dynamotor or motor generator is the only practical method for such transformation.

Size of Wire

Question: Please explain how I can find size of wire required to transmit 40 horsepower 9 miles at 6,000 volts, with 2½ per cent loss. System to be 3-phase.—*N. S.*

Answer: The size of wire in circular mills can be obtained by the formula

$$C.\ M.=\frac{W\times D}{P\times E^2}\times K,$$

in which W = total watts delivered; D = distance one way in feet; P = percentage of loss; and E = voltage; while K is a constant, which, for the 3-phase 3-wire system at 85 per cent power factor, is 1,500. The power factor will depend upon the nature of your load. As this is not stated, we shall assume that it consists of a combination of motors and lights, for which the power factor should be in the neighborhood of 85 per cent. Substituting these values in the formula, we have

$$C.\ M.=\frac{9\times 5,280\times 40\times 746}{6,000^2\times 2.5}\times 1,500,$$

from which we find that $C.\ M. = 23,633$. Then, referring to wire table, and choosing the next larger size of wire, will give us No. 6 B. & S., which, from the standpoint of drop in voltage, would be the proper size to use.

Voltmeter Reading—Exciter Load—Hysteresis Loss—Conversion of Logarithms

Question 1: Will a voltmeter, either A. C. or D. C., give a different reading when it is warm, from that given when cold, with the same pressure at the terminals—say, because of a change of temperature in the room? If so, what percentage of difference in the reading will the change in temperature cause?

Question 2: In what way does the load change on the exciter of a separately excited A. C. unit, when the load changes on the alternator?

Question 3: Does the hysteretic loss change with change of temperature in armature or in any other piece of apparatus?

Question 4: Which is the right constant or multiplier to use in changing common logarithms to hyperbolic logarithms—2.302585 or .434294?—*W. C. S.*

Answer 1: This depends on the instrument. Some instruments are compensated for change of temperature, and some are not, while others use a wire that has almost zero temperature coefficient. The Weston A. C. voltmeters have a small rheostat which adds or cuts out resistance in circuit, to compensate for temperature changes as indicated by an enclosed thermometer. The amount of difference in reading depends on the instrument used.

Answer 2: As the load on the alternator increases, voltage drops, and a greater current is required from the exciter. This applies to simple alternators. In compound ones, the exciter load varies very little.

Answer 3: Not appreciably within practical working limits.

Answer 4: Multiply by 2.302585, or divide by .434294.

Electrolytic Effects of Weather

Question: On a roof, when the copper of the valley is soldered to a galvanized-iron gutter in the cornice, will any action, electric or otherwise, take place, that will destroy or partly destroy either metal at the line of junction, causing a leak? I have such a case now under construction.—*G. W. S.*

Answer: Where two different metals are in contact in presence of moisture, an electrolytic action is set up, with slow destructive effects. This would probably occur in the case mentioned.

Brushes of Compound-Wound Dynamo

Question: Will you please tell me why a compound-wound dynamo can be run with only two sets of brushes? This is a 4-pole dynamo, and the brushes are 90° apart. The dynamo is used for lighting, and is about 10 H. P.—*E. T. S.*

Answer: A machine with a simple wave winding can always be run with two sets of brushes, although more (a pair for each pair of poles) are usually used, in order to reduce the current density in the brush contact. Lap windings must always have as many sets of brushes as poles, in order that all the armature windings may be utilized symmetrically at the same time. This becomes evident by referring to the accompanying figures. Fig. 1 is a 4-pole drum

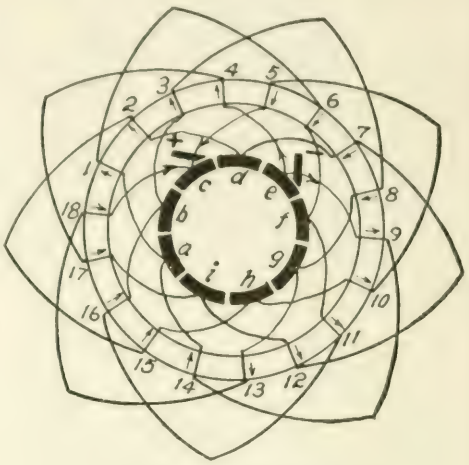


Fig. 1. Four-Pole Drum Wave Winding.

wave winding. Starting at the negative brush where the current enters the armature, there are two paths to the positive brush; but through either path the current must circulate entirely around the

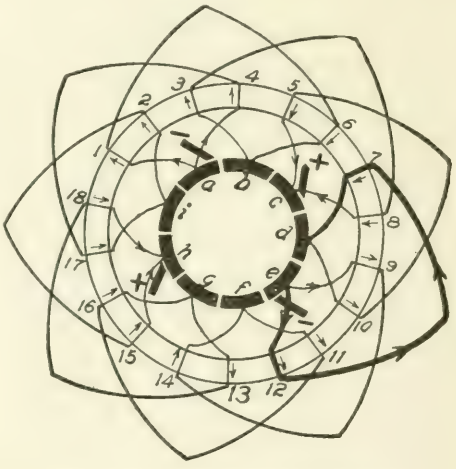


Fig. 2. Four-Pole Drum Lap Winding.

armature, the number of times depending on the winding, so that the current density in all parts of the armature is the same and no unbalancing results.

Referring in a similar way to Fig. 2, which is a 4-pole drum lap winding, it will be seen that if there be only two

brushes used, as in Fig. 1, the current entering at the negative brush has two paths to the positive one, but one is three times the length of the other and of correspondingly high resistance; hence nearly all the current will seek the shorter path, which will result in serious unbalancing of the electric circuit, and the possible maximum load will be lowered accordingly.

Formulas for Black Prints

QUESTION: Please give formulas and directions for making black prints, both negative and positive.—*J. W. C.*

Answer: The paper on which the negative is to appear is first dipped in a bath consisting of 30 parts of white soap, 30 parts alum, 40 parts English glue, 10 parts albumen, 2 parts glacial acetic acid, 10 parts alcohol (of 60 degrees), and 500 parts water. It is afterward put in a second bath which contains 50 parts burnt umber ground in alcohol, 20 parts lampblack, 10 parts English glue, and 10 parts bichromate of potash, in 500 parts water. The paper is now sensitive to the light and must be kept in a dark place. In preparing paper to make the positive prints, another bath is made just like the above except that lampblack is substituted for the burnt umber. To obtain colored prints, any soluble pigment of the desired color may be substituted for the lampblack.

In making the negative, the drawing to be copied is placed in a photographic printing frame, the negative paper laid on it and then exposed in the usual way for two minutes in clear weather. After the exposure, the negative is put in clear water to develop, and the drawing will appear in white on a dark ground. It is a negative or reversed picture. We can now use this to make as many positive copies as we choose, as follows:—Place the negative after drying, in a print frame, next the glass; and the positive paper, prepared as above, next to it; expose for two minutes, and develop the positive in water. The pigment will dissolve leaving the lines sharp and distinct on a white ground.

Increase of Voltage in Lighting Circuits

QUESTION: We made a recent change in our electric lighting, voltage being increased from 110 to 220. We also changed lamps from 110 to 220. As a result of this change, the light seems to be too strong, and from two to three lamps burn out every day. Could we get a higher voltage lamp, or is there any way to remedy this trouble?—*O. C. J.*

Answer: There is no apparent reason why a 220-volt lamp of a given candle-power on a 220-volt circuit should burn any more brightly or burn out in less time than a 110-volt lamp of the same candle-power on a 110-volt circuit. It would seem as though the voltage had been increased to more than 220. If this is the case, you should, of course, get a lamp of the proper voltage to correspond, which would have the desired result of causing your lamp to burn less brightly, and would also undoubtedly increase the life of your lamps considerably.

Air-Brake Details

QUESTION: 1: In the Westinghouse air-brake, what is the size of the feed-groove in the triple?

QUESTION 2: If the train-line pressure is reduced below auxiliary reservoir pressure after equalization between auxiliary and brake cylinder has taken place, what will occur?—*N. A. R.*

Answer 1: Size of feed-groove varies according to the auxiliary reservoir used in connection with same, each style triple having a separate gauge. The practice is to make the groove of such capacity that the auxiliary can be supplied at the rate of one pound per second from a 70-pound train-line pressure.

Answer 2: The piston will move to the left and compress a graduating spring, but to no special advantage.

Setting Lathe Tools

How Cutting Tools Should be Adjusted on the Lathe In Relation to the Work

By FREDERICK W. TURNER

Instructor in Machine Shop Work, Mechanic Arts High School, Boston, Mass.

THE cutting tools used in lathes are of a great variety of shapes. These shapes are adapted to the work that is to be done, and to the kind of finish that is to be left upon the metal. There are two fundamental requirements that all tools must fulfill: (1) *The cutting edge alone must touch the metal;* (2) *the edge must be keen.* A typical form of tool is shown in Fig. 1. The cutting edge of the tool at *A* is in contact with the work. The bottom line *A B* runs back from the metal and does not touch it. The top face *A C* slopes

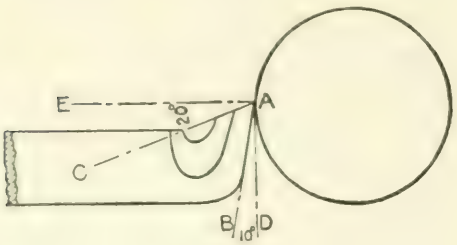


FIG. 1.

down and back. The line *A D* is a tangent at the cutting point, and the line *A E* is radial at the same point. Therefore, the angle *D A E* is always a right angle. The angle *D A B* is called the angle of *clearance,* and should be small; in lathe tools, not over 10°. The angle *C A E* is called the angle of *rake,* and should be as great as circumstances will permit; about 20° on lathe tools for wrought iron and steel, leaving 60° for the *solid* or *cutting* angle, which is the same angle as is used for a cold chisel.

Tools Should be Strong

Clearance prevents the tool from rubbing on the work, while rake adds to the keennees of the cutting edge, and gives freedom to the removal of the chips. A tool should have sufficient strength at the point to do the work required.

The tool should be set so that the cutting edge will be very nearly at a horizontal line, passing through the axis of

FIG. 2.

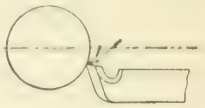


FIG. 3.

the work. Many machinists set the cutting edge a little above the horizontal line. When so set, the stress tends to force the tool down along the line of its greatest strength. The tool may, however, be set too high. If this is done, as in Fig. 2, the angle of clearance will disappear, and the curve of the work will rub against the bottom of the tool. This will tend to force it out; it will heat the steel and produce a rough surface on the metal being turned. If, on the other hand, the tool is set too low, as in Fig 3, the cutting edge does not stand in line with the motion of the work at the point of contact. The result will be that the metal will be scraped rather than cut, as there is no rake, and the pressure upon the tool will be in the line of its lowest

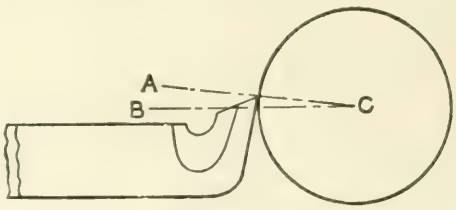


FIG. 4.

power of resistance, as indicated by the arrow. Such a position might cause the point of the tool to break off. It will also cause the tool to tremble or "chatter" as

it removes the chips, leaving a rough and wavy surface on the metal.

How Cutting Edge Should be Set

As stated above, many machinists prefer to set the cutting edge a little above

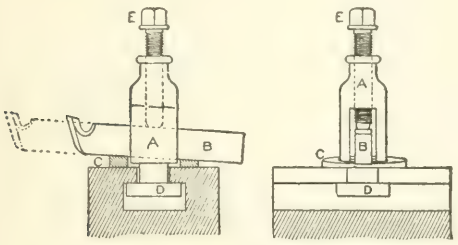


FIG. 5.

the center; if this is done, the rotation of the work has a tendency to depress the point of the tool a little, bringing it, while cutting, nearly to the center. The amount the tool is set above the center is slight, and of course depends upon the character of the work. The angle *A C B*, Fig. 4, should be only about 5 or 6 degrees.

The tool is usually held to the carriage by means of a tool-post, shown in Fig. 5. The post consists of a piece with a slotted hole through the center for the tool *B*. A ring *C* slips over it and rests upon the body of the carriage. This ring may be beveled as shown, to provide ver-

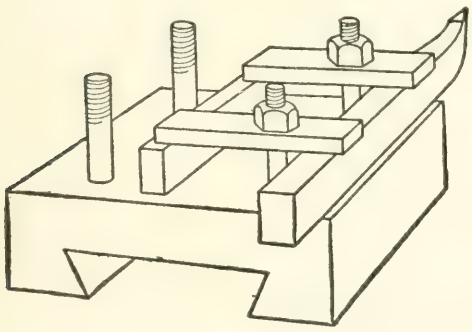


FIG. 6.

tical adjustment for the point of the tool. The post has a collar *D* at its lower end, that goes loosely into a slot in the carriage. At the top there is a set screw *E*. When the tool has been properly adjusted by turning the ring *C* to give it the correct elevation, the set screw is tightened down upon the top of the tool. This raises the tool-post to a bearing on the under side of the slot, and clamps the whole carriage firmly in position.

Overhang to be Avoided

In setting the tool, it should be done with the cutting edge as far back towards the supporting ring as possible. If it has too much overhang, as shown by the dotted lines of Fig. 5, it will spring under the pressure of the work and will chatter.

While this form of tool-post is used more than any other, there are certain objections to it. In the first place, changing the height of the tool point also changes the angles of rake and clearance.

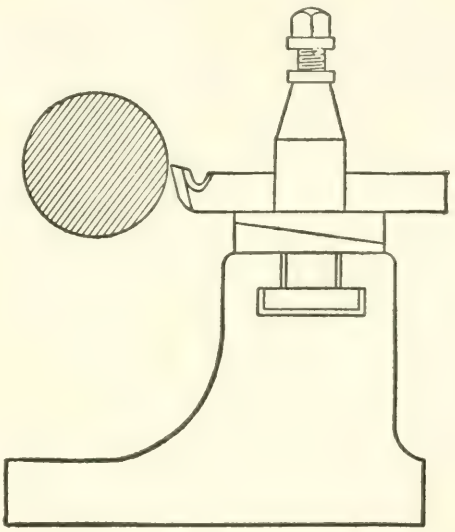


FIG. 7.

These are supposed to be correct when the base of the tool is horizontal. Any change from this position alters the sizes of these angles materially. Again, this post is not rigid enough for heavy work. On lathes of over thirty inches' swing, the style of tool-holder shown in Fig. 6 is often employed. English manufacturers use it almost exclusively on all sizes. There is no provision for raising and lowering the point of the tool; and while this is not of serious importance on large lathes (30-inch and over), it becomes a matter of moment when turning such work as is usually handled in lathes of 14-inch and 16-inch swing.

The form shown in Fig. 7 has two beveled rings to adjust the height of the tool.

Best Form of Tool-Post

The Lipe tool-post, shown in Fig. 8, combines the good points of all the other forms; the tool can be held by one or two screws as the character of the work may require, and can be adjusted vertically or horizontally after being clamped

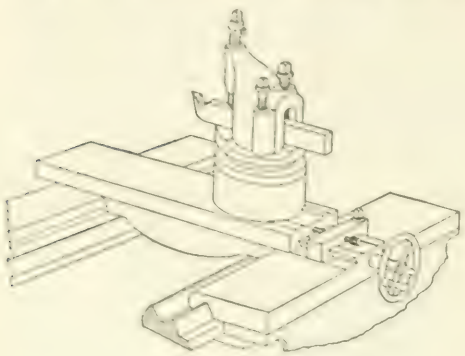


Fig. 8.

down. The construction and operation of this tool-post are clearly indicated in the illustration.

An entirely different method of adjusting the tool point is by means of what is called the elevating or rise-and-fall rest shown in Fig. 9. In this type there is a T shaped casting carried on the upper

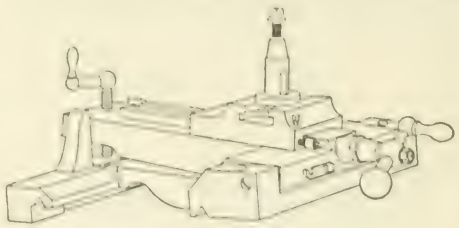


Fig. 9.

part of the carriage, supported by trunnion screws at the front, and by an adjusting screw at the rear. With this is used a tool-post as shown in Fig. 5, with a plain ring. The elevating rest is used quite extensively on small lathes, but the convenience of adjustment is gained by a loss in rigidity. The cross-rail is light, and the elevating portion, being supported at three widely separated points, lacks stiffness. As the effective swing over the carriage is limited by the height of the cross-rail and the parts carried above it, they are made light—too light in many cases.

Backbone

I'VE paid close heed to the ways of men;
I've observed what the world calls luck;
I have silently marveled, now and then,
At the potent power of pluck;
And this as a bit of truth I hail,
A sentence that's worth one's heed—
The man who is always afraid he'll fail
Doesn't stand much show to succeed.

Course in Sloyd for Boys

by

HARRIS C. TROW B.S.
Graduate Sloyd Training School of Boston

Sloyd is the Swedish system of manual training, as originated and taught by Herr Otto Salomon of Näas, Sweden. Sloyd differs from other systems of manual training in that it has for its object the harmonious development and training of head and hand. The course of which this is the third lesson, was begun in the December, 1905, number of this magazine, and is intended for boys of from twelve to eighteen years of age, and can be followed in the home, with the simplest tools. The course will be found just as valuable to the young man who intends to take up a professional career, as to him who proposes to follow a handicraft.—THE EDITORS.

Third Lesson—Model No. III. Coat-Hanger

THE complete model, which is, of course, perfectly familiar to everyone, is shown in Fig. 1. The new tools required in its construction are a crosscut saw, 22-inch, 10 points, price $1.42; a marking gauge, oval head, price 25 cents; a block plane, 7-inch, Bailey iron, price 72 cents; a bench hook, oak, price 30 cents; a turning saw, 12-inch, price $1.00; a spoke shave, iron, price 15 cents; and a brad awl, price 10 cents.

The wood should be good, clear white pine of ⅞-inch thickness.

A piece of stock should be blocked out about 15¾ inches long and 2¾ inches wide. The cuts with the grain should be made with the splitting saw; and those across the grain, with the crosscut saw. In blocking out stock for any model, it is well to work as close to the finished dimensions as possible, leaving only the amount of stock actually necessary for finishing, thereby saving time and material. The cuts with both the splitting and the crosscut saw should therefore be made straight and square.

Referring to Fig. 2, it is evident that we must finish the stock, by means of planing, to a rectangle 15½ inches by 2½ inches, and ¾ inch in thickness. The following general rules for planing should be studied carefully, and preserved for future reference:

Rules for Planing

1. Plane one *broad* face smooth and true—Mark "1."
2. Finish one *narrow* face at a right angle to the first—Mark "2."
3. Gauge *width,* and plane.
4. Gauge *thickness,* and plane.
5. Block plane one end true.
6. Take length, and block plane.

File and sandpaper should not be used until the work is as well done as possible with the edge tool.

First plane one of the 2½-inch surfaces straight and true, in direction both of the length and of the width. Care should be taken not to leave the surface crowning in either direction. This fault is more common than that of leaving the surface concave, although the latter is perfectly possible when the length of stock is greater than the length of the plane or its width is greater than the width of the plane. The straightness of the piece longitudinally may be tested with the eye; its straightness in the direc-

tion of the width, by the try-square blade or any other straight edge. If crowning, the straight edge will rock; and if concave, light will be shown under its center. The eye can be depended upon here also to a great extent, especially after a little practice. Mark this surface "1."

FIG. 1. COMPLETE MODEL.

Next plane one of the narrow surfaces straight and true, and perfectly square with surface 1, as described in the previous lesson. Mark this surface "2."

The next exercise is one with a marking gauge. Set this by means of the rule so that the distance between the spur and the head is exactly 2½ inches. Then lay off on surface 1 this width from surface 2. The head of the marking gauge, of course, rests against surface 2, while the gauge is drawn along the length of the work, always keeping the shaft at right angles to surface 2. Having in this manner laid off the width, the next exercise is to plane the piece to this line, remembering that here the cut must be perfectly straight and square at the instant the line is reached, as no further stock can be removed without losing dimensions. Mark this surface "3." Next set the gauge to ¾ inch, and gauge the thickness on both surfaces 2 and 3. Plane stock to these lines.

Having finished the stock to width and thickness, the next operation is that of truing the ends and finishing the piece to length. This is done by means of the bench hook and block plane. The piece should be placed in the bench hook, as shown in Fig. 3, where *A* represents the plan view and *B* the side elevation. The block plane is used, resting upon its right side, with its face against the right-hand edge of the bench hook, as shown at *A*.

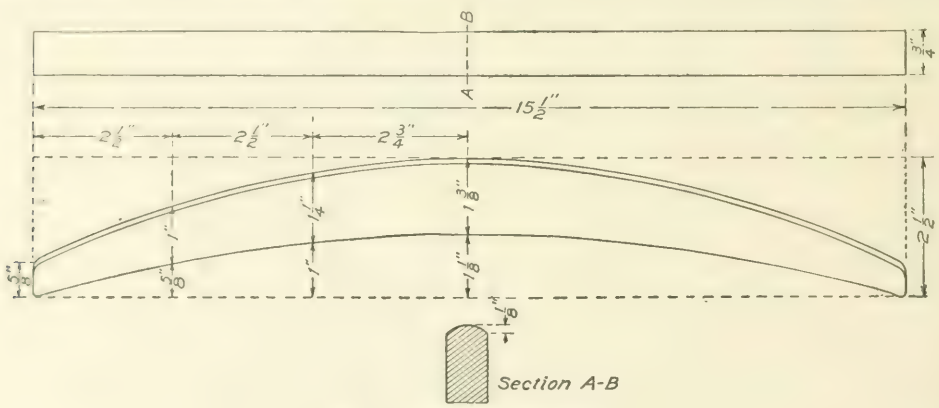


FIG. 2. WORKING DRAWING.

The stock should be allowed to protrude beyond the edge of the bench hook only enough to permit a thin shaving to be removed at each cut. If the bench hook and block plane be used properly as described, the squareness of the end with surfaces 1 and 2 will take care of itself.

After testing the end and finding that

it is square and true, the length, 15½ inches, should be laid off and the other end block-planed to the line.

We are now ready to lay off the coat-hanger, which can be done by drawing in, very lightly, the vertical lines shown in Fig. 2 and locating the points thereon as indicated. Only the upper and lower curves should be drawn at present. These curves can be and should be sketched in freehand, and this will be found comparatively easy after a little practice. The smoothness of the curve should be tested by looking along its length with the eye. Strive to get a free full-arm stroke in drawing it, as only in this manner can a smooth curve be obtained.

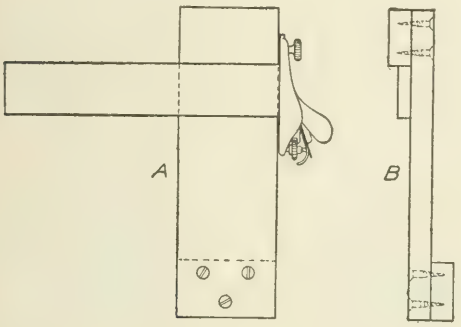


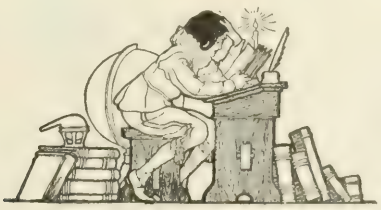
FIG. 3. ILLUSTRATING PROPER USE OF BLOCK PLANE.

The work should now be roughed out to the curved lines with the turning saw, cutting from the center to the ends on the upper curve, and from the ends to the center on the lower curve. Try to keep this cut as square as possible with the broad surface on which the curves are laid out.

Having made these saw cuts as close to the line as possible without cutting under, finish to lines by means of the spoke shave, drawing it from the center to the ends of the upper curve, and from the ends to the center of the lower curve. These cuts should, of course, be kept square with surface 1, and they should be made long and smooth rather than short and choppy.

Next, the curved line, shown in Fig. 2, ⅛ inch below the upper curve, should be drawn by placing the end of the second finger against the upper surface, with the point of the pencil projecting ⅛ inch onto the broad surface. This makes a very convenient form of marking gauge, and by following the curve of the upper surface with the end of the finger, the point of the pencil will trace the desired curve. Such a line should be drawn on both the front and the back of the work; and the upper surface should be rounded with the spoke shave, as shown in the section on *AB*, Fig. 2.

All surfaces should now be sandpapered, using the block as described in Lesson 2, for all except the upper surface. This surface should be sandpapered by holding a piece of sandpaper between the thumb and fingers of both hands, and resting on the work so that it will exactly conform to the ⅛-inch round already roughly given by the spoke shave. After the finishing touches have been put on by the sandpaper, the hole for the hook should be made with the brad awl. The brad awl should be used with the edge perpendicular to the grain, to avoid splitting. The hook, shown in Fig. 1, can be secured at a hardware store, and should now be screwed into position, when the model will be completed.



Weather-Wise

WHEN a nervous young man in Berlin
By mistake had jumped out of his skin,
He cried out, "Oh pshaw!
One feels rather raw,
But it's much cooler outside than in."
—*E. V. D. in Lippincott's.*

How it Affected Them

A LUNATIC-ASYLUM keeper in an Eastern watering-place not far from Newport, R. I., was showing the regulation inquisitive visitor

about the plant. A large room with about twenty cots was reached, but the place seemed empty.

"This is where the crazy chauffeurs are kept," said the keeper.

"Oh, is it?" asked the visitor, "but where are they?"

The guide replied: "Well, you can't see 'em. They're all under the beds examining the springs."—*Pittsburg Despatch.*

Essay on the Horse

A NATIVE student of English at Bombay, India, wrote the following lucid essay:

"The horse is a very noble quadruped, but when he is angry he will not do so. He is ridden on the spinal cord by the bridle, and sadly the driver places his foots on the stirrup and divides his lower limbs across the saddle, and drives his animal to the meadow. He has a long mouth and his head is attached to the trunk by a long protuberance called the neck. He has four legs; two are on the front side, and two are afterward. These are the weapons on which he runs and also defends himself by extending those in the rear in a parallel direction toward his foe, but this he does only when in a vexatious mood. His fooding is generally grasses and grains. He is also useful to take on his back a man or woman, as well as some cargo. He has power to run as fast as he could. He has got no sleep at nighttime, and always standing awaken. Also there are horses of short sizes. They do the same as the others generally doing. There is no animal like the horse; no sooner they see their guardian or master they always crying for fooding, but it is always at the morning time. They have got tail, but not so long as the cow and other such like similar animals."—*Chicago Chronicle.*

Scrublady's Family

R. CLINTON PERRY, the sculptor, is responsible for the following story of the "scrublady" who cares for the studio:

"How many children have you, Mrs. O'Flarity?" he asked her one morning.

"It's siven I have, sir," she replied. "Four be the third wife of me second husband, three by the second wife of me furst."—*New York Tribune.*

New Use for Husbands

HERE'S a letter from a woman," said the answer-to-correspondent editor, "who wants to know what to use in cleaning carpets."

"If she is a married woman," suggested the snake editor, "tell her to use her husband."—*Chicago News.*

Witty Mr. Smith

MR. AND MRS. SMITH were sitting in the front row in the gallery of a church when a man downstairs was carried out in a fit. The next Sunday they were in their accustomed seats when the same man walked up the middle aisle.

Mr. Smith whispered to his wife:

"The survival of the fittist!"—*Life.*

Promise of Plenty Doing

THE following notice was tacked on the wall in the vestry of the Bethesda Methodist Colored Church in a Southern city:

"There will be a picnic of this society in Green Grove next Friday beginning at nine

A. M. in the morning. Good behavior is requested from young and old, and nothing will be left undone which would tend to mar the pleasure of the company."—*Elizabeth L. Gould in Lippincott's.*

Why the Check Did Not Come Forth

RICHARD LE GALLIENNE, one of the best known of writers, went to a publication office to get a check which was due him for an article.

"I am sorry," said the cashier, "but I shall have to disappoint you to-day. The checks are made out, but they are without the signature of our manager. He is ill with the gout."

"Extend him my sympathies," murmured M. Le Gallienne. "It must be very trying for him to be so disabled. I infer that he signs his checks with his feet."

Could Stand Another

DINNER was a little late. A guest asked the hostess to play something. Seating herself at the piano, the good woman executed a Chopin nocturne with precision. She finished, and there was still an interval of waiting to be bridged. In the silence she turned to an

old gentleman on her right and said, "Would you like a sonata before dinner?" He gave a start of surprise and pleasure. "Why, yes, thanks!" he said. "I had a couple on my way here, but I think I could stand another."—*Harper's Weekly.*

Feasts

I SUPPOSE those feasts given by Lucullus were the most expensive ever served."

"Lucullus? What insurance company was he connected with?"—*Rambler.*

On the Sea Wall

THEY were sitting side by side;
He sighed, and she sighed;
Said he, "My dearest Idol;"
He idled, and she idled;
"On my soul there's such a weight;"
He waited, and she waited;
"I'd ask your hand, so bold I've grown;"
He groaned and she groaned;
"You shall have your private gig;"
He giggled, and she giggled;
Said she, "My dearest Luke;"
He looked, and she looked;
"I'll have thee if thou wilt;"
He wilted and she wilted.

A Definition

GLADYS—Mamma, what is a "cursory glance?"

MAMMA—It is the kind of look that your father gives when he wants to swear but doesn't dare.—*Roslyn News.*

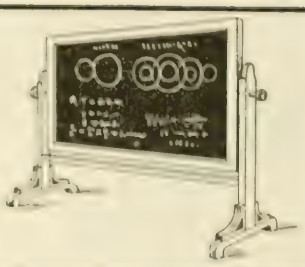
Smart Dog!

I HAD a little doggie once—
A clever little pup—

He'd stand upon his hind legs, if
You held the front ones up.

CHALK TALKS

by CARL S. DOW.



Number Twenty-Four—The Helix

THE draftsman is called upon frequently to draw screw threads, coil springs, and other parts of machinery involving a curve called a *helix*. On account of its importance, an acquaintance with the method of drawing this curve is desirable.

Even a slight examination of a screw thread, such as appears on a bolt, will show that it is simply an inclined plane wrapped around a cylinder. To prove this, take a piece of paper of rectangular shape, as shown in the first figure on the blackboard. Make the long side *AD* equal to the circumference of the bolt, and the height *AB* equal to the pitch* of the thread.

Now draw the diagonal *AC*, and cut the paper on this line. If the inclined plane or right triangle *ACD* is wrapped around the bolt, the line *AC* will coincide with the thread.

Construction of the Curve

We know that the thread of a screw advances along the length a distance equal to the pitch for every turn. Therefore, for a quarter-turn, a point on the thread will advance one-quarter of the pitch; for a half-turn the point will move one-half the pitch; for a twelfth-turn the point will move one twelfth the pitch; and so on.

This gives us an idea of the method of drawing the curve. Points must be located to determine the curve, and each of these points must conform to the conditions as stated above.

To draw the curve, the diameter of the cylinder and the pitch of the helix must be known. The method is shown in Fig. 2. The circle shows the cross-section or plan; and the rectangle shows the elevation of the cylinder. Now divide the pitch *CD* into any number of equal parts—twelve, for instance; and then divide the circumference of the circle into the same number of equal parts. Number or letter the parts to correspond. In the figure shown, the divisions are numbered 1 to 12. The point *D* or 12 in elevation corresponds to point 12 in plan. This is assumed to be the starting point, although any other might be chosen.

To find the second point, draw a horizontal line through point 1 in elevation, and a vertical line through 1 in plan, as shown; where these lines meet, call the point *E*. This is the second point. To prove this, simply consider that the point in question has moved $\frac{1}{12}$ of a revolution (see plan), and at the same time has advanced $\frac{1}{12}$ of the pitch (see elevation).

The third point *F* is found in the same way. Draw a horizontal line through 2 in elevation and a vertical line through 2 in plan. Points *G, H, I, and J are* found in a similar manner; also points *K* to *P*, inclusive.

In locating these points, we find that when we have reached *P* we have used 12-twelfths of the revolution and 12-twelfths of the pitch.

After all the points have been determined, draw a curve through them. From *D* to *J* the curve should be a full line, for this portion is in front From *J* to *P* the curve is on the back of the cylinder, and should be dotted, because all invisible lines are thus represented.

The helix shown in Fig. 2 is right-handed. To draw a left-handed helix,

*NOTE—The *pitch* of a screw thread is the distance between two threads measured along the axis or length It is the distance the bolt advances in the nut for one turn.

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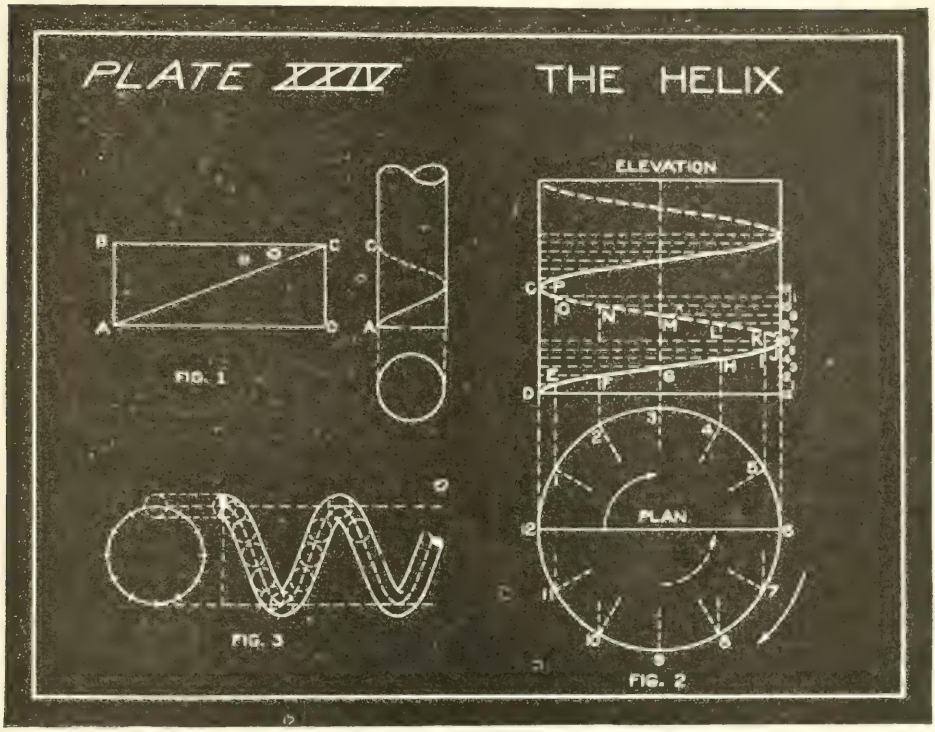

commence at point 6 (plan) and corresponding point in elevation, and reverse direction in plan, as shown by dotted arrow.

The Spring

A helical spring is formed by winding a wire instead of the line about a cylinder. This is shown in Fig. 3. In this case also, we must know the pitch and the diameter of the cylinder, as well as the diameter of the wire.

When the diameter to the middle of the wire is known, or has been calculated, draw a circle of this diameter. Now draw the elevation as shown dotted in Fig. 3.

As in the preceding case, draw the helix. This will be the center of the wire; and to show the wire, draw numerous circles on this center line, each having a diameter equal to the diameter of the wire. To get the outlines of the spring, draw curves tangent to the small circles.

A helical spring of square section is drawn by the same method.

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In the morning, the pail may be set on a stool, and the slow seeping of water through the wick is started by suction. The wick at the end of the long leg of

Automatic Apparatus for Watering Plants.

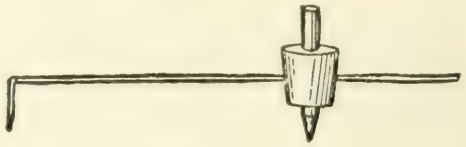
the improvised siphon is separated into several strands, one strand being placed in each pot to be watered. The caretaker may now go away for the day with the assurance that his flowers will receive all the water necessary. In warm weather, it is best to cover the pail and wrap the tube with cloth, to prevent the wick drying. The German inventor of this device says it has always worked successfully.

To Waterproof Leather

The following recipe for water-proofing shoe leather has been thoroughly tested and proved successful: One pint boiled linseed oil, one half-pound fresh mutton suet, six ounces clean yellow beeswax, four ounces yellow resin. Melt the ingredients and mix well. Apply when warm, but not hot, and rub into the leather. This recipe is said to be used by New England fishermen with perfect satisfaction. They often stand for hours in water, without damp feet.

A Cheap Compass

To make an inexpensive compass, all that is needed is a large cork (or rubber), a piece of stiff wire, and a short pencil.



The wire should be about 8 inches long, and should be bent to a right angle one inch from the end, and the end sharpened. The pencil is fitted vertically in the cork (or rubber), and the latter clamps the wire tightly, and may be moved in or out to make a small or large circle, as desired.

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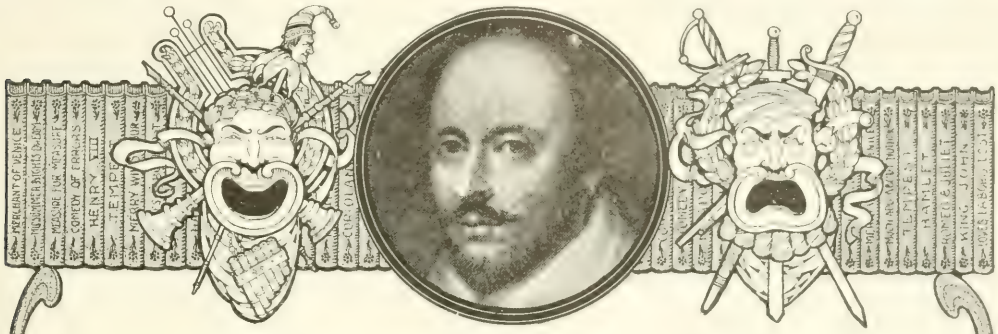

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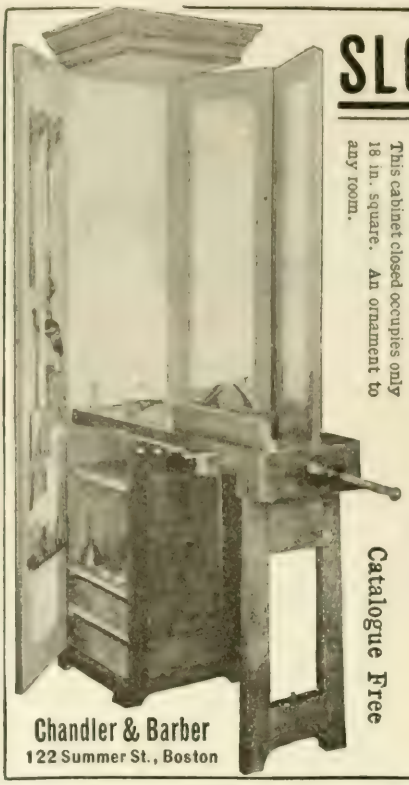

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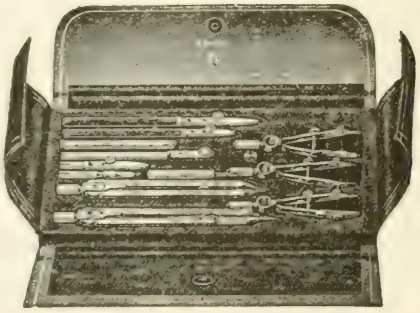

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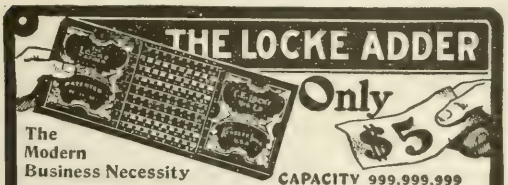

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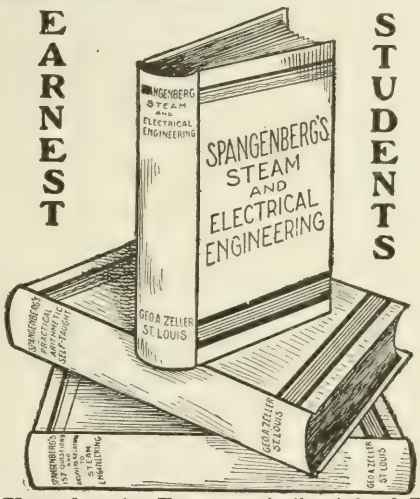

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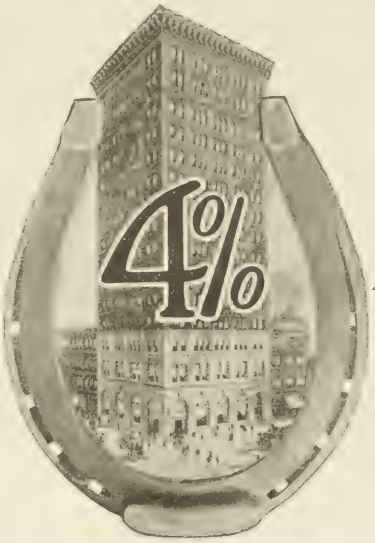

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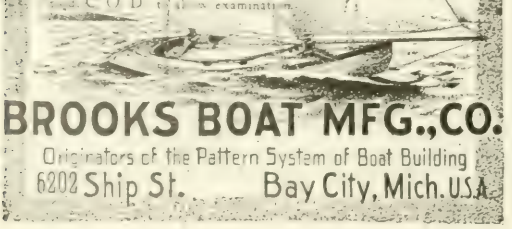

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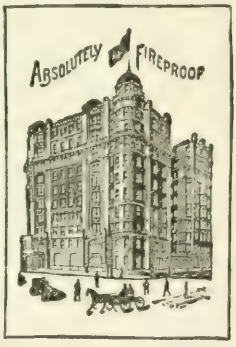

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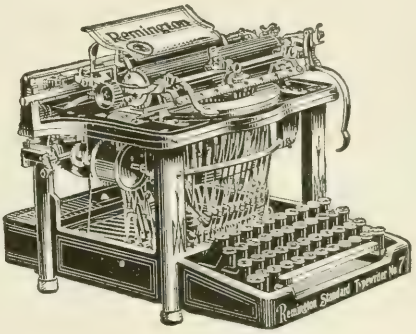

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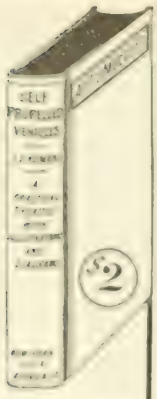

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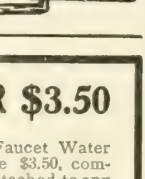

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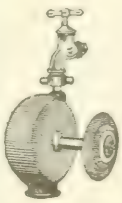

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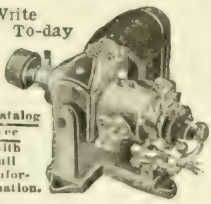

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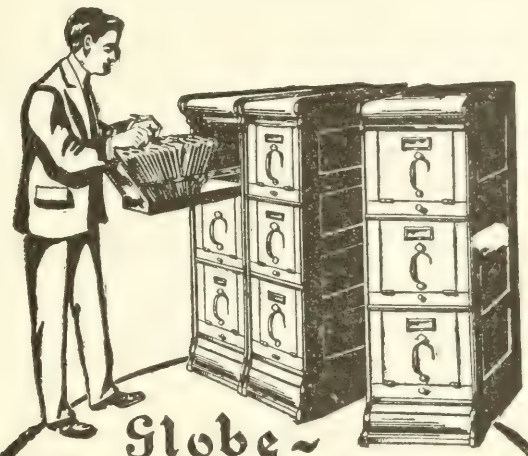

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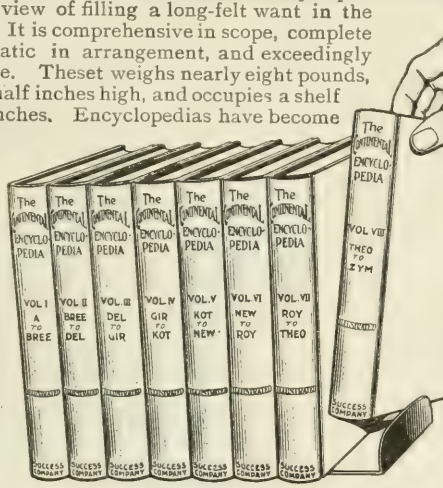
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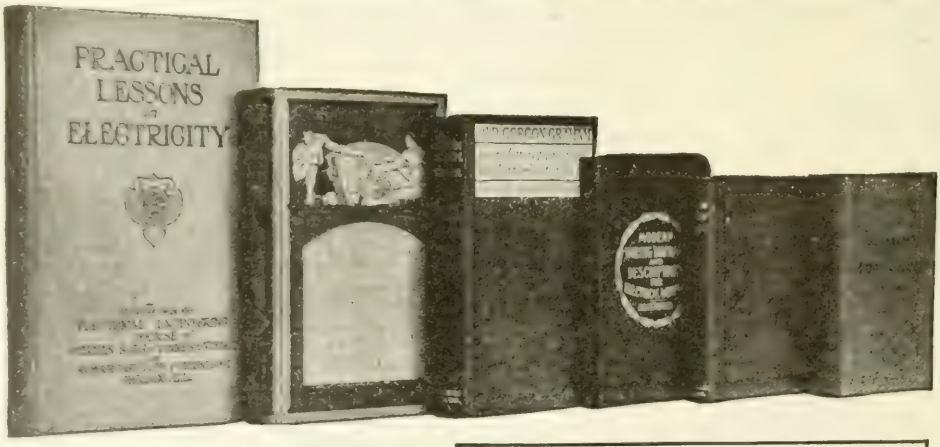

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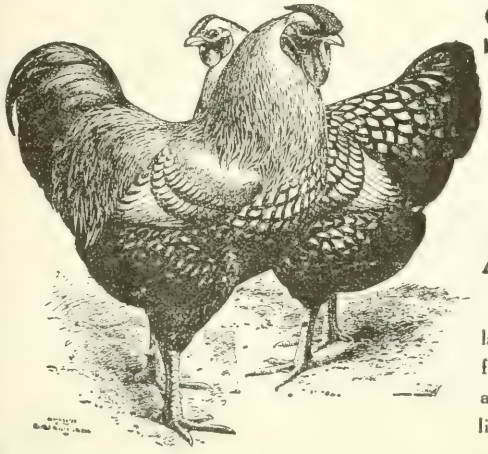

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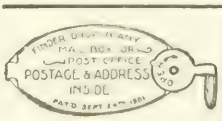

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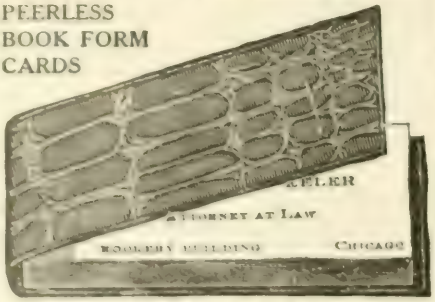

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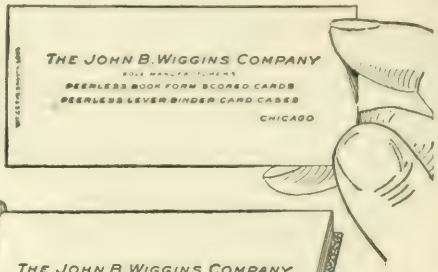

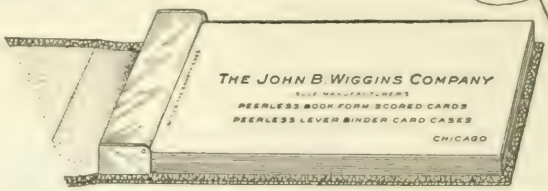

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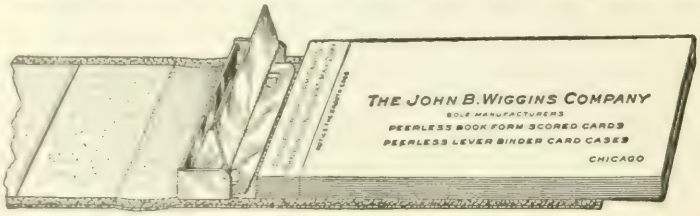

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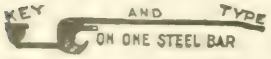

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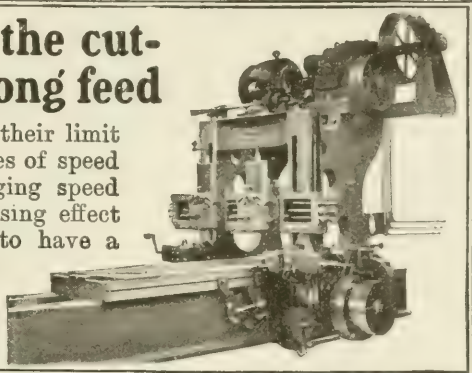

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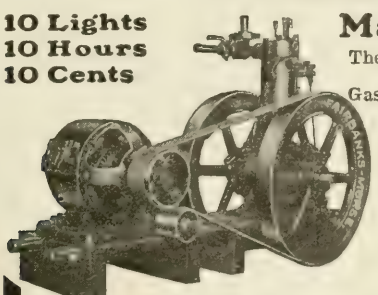

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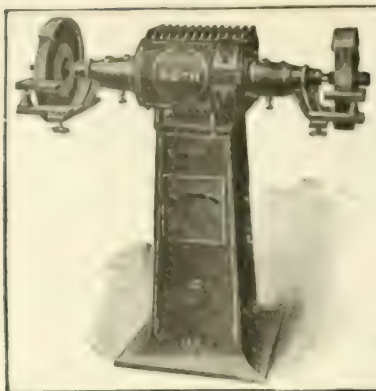

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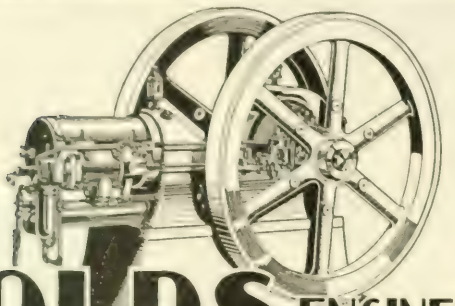

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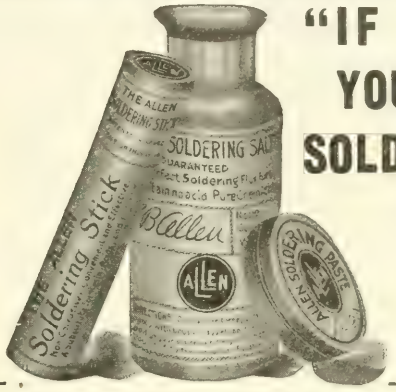

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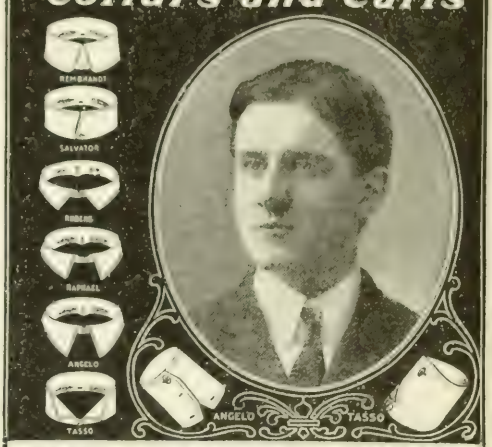

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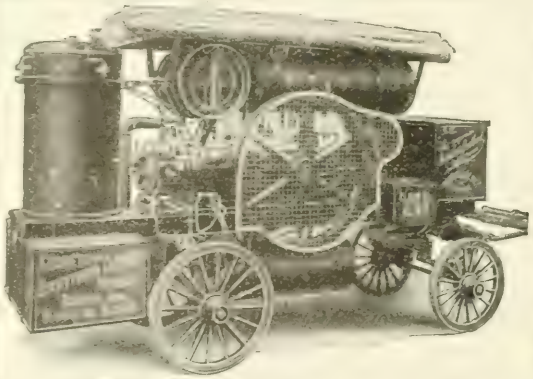

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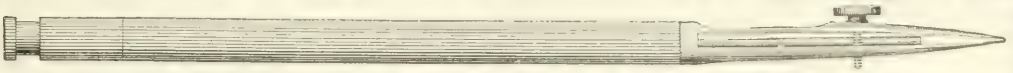

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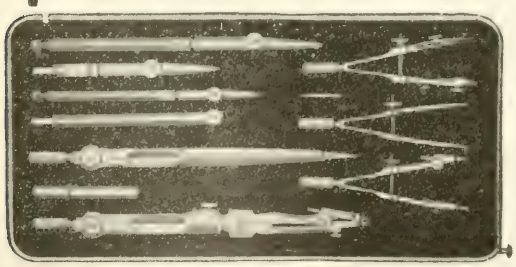

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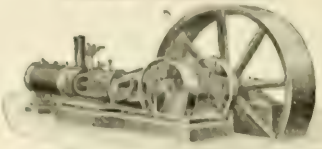

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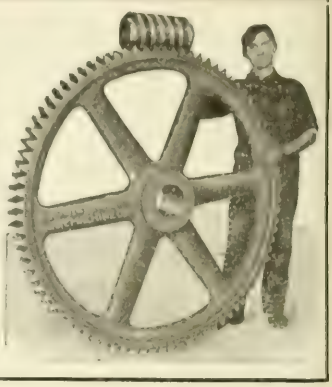

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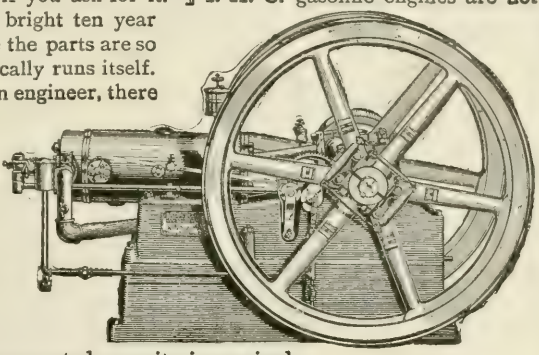

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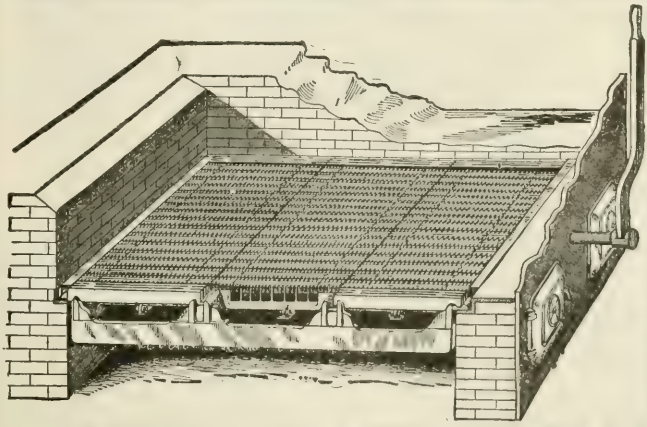

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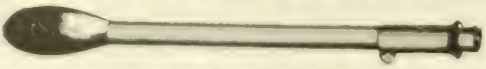

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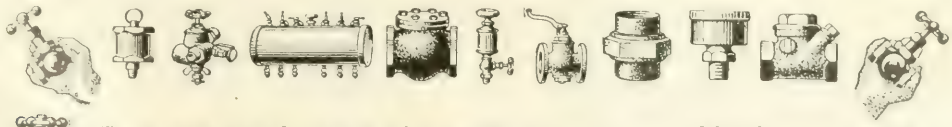

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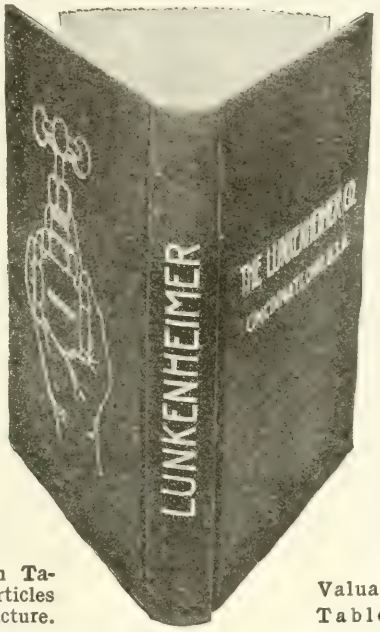

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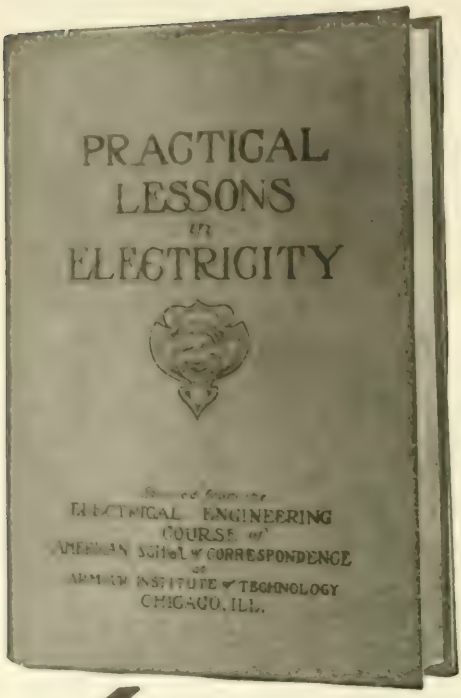

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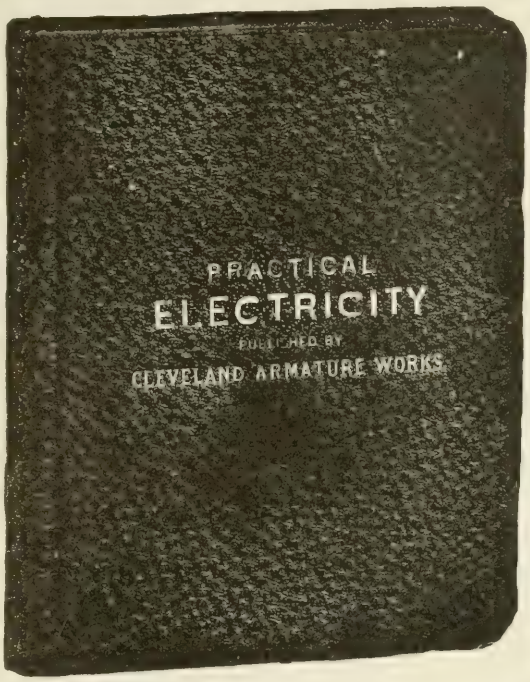

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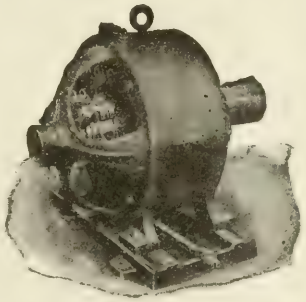

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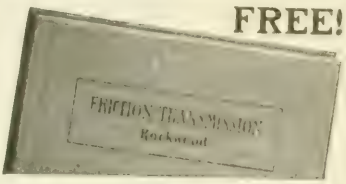

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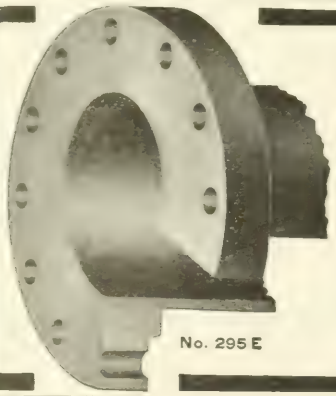

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"When I buy a thing and get my money's worth I don't hesitate to say so. I purchased from you, five months ago, an Evans Vacuum Cap, and it has given me the very best of satisfaction and has accomplished all you claimed and more. My case was obstinate at first, but by persistent effort in the use of the Cap I am fully satisfied with results. To my mind it is the only rational manner of treating the scalp to put it into a thoroughly healthy condition and I have made quite a study of the matter. You are quite at liberty to refer any prospective customers in this section to me, either personally or by letter, but I do not wish this letter used as a published testimonial."

"I would like to report my progress with your Cap and will say that it has loosened up my scalp very much, but I find that my hair still falls some and wish to ask for further advice. The Cap has started a new growth of hair, but I find that the new hair comes out after growing from one to two inches in length. I enclose a few hairs and you will please notice that they are a new growth. Is it that the follicles will produce two or three growths before they become healthy? Now I suppose that your treatment will take some time to get the hair in a healthy condition, as my scalp has been so tight for some years. Would like to hear from you on the subject."

"After thirty days' use of your Vacuum Cap the fuzz on my head has started to grow. I had been losing my hair for over twelve years and my scalp was very tight, but now it is quite loose and I can move it back and forth. Is there any way to keep the Cap from coming down in front? That is the only thing that bothers me. I have written to the Jefferson Bank instructing them to give you my deposit. There has been a few gentlemen here watching the trial of the Cap and I think you will now receive more orders from this place."

"I have just received the chair clamp and letter of advice, for which accept my thanks. Will state that I have now been using the Cap for a little more than a month and am convinced that it is indeed a blessing to a man who really values his hair. I paid $50.00 to a New York Specialist whose treatment failed to stop my hair from falling out, and which your apparatus has accomplished in a reasonably short time. The price you charge for the Cap is out of proportion to the benefits received and in fact I look upon it more as a gift than a purchase."

"I believe that any man whose blood is in good condition can cultivate a healthy and complete growth of hair. I had been losing my hair for about ten years and there was a bare space about three inches wide extending from front to the back part of my head. I saw the advertisement of the Evans Vacuum Cap in Munsey's Magazine some time ago and the logic of the argument appealed to me. I cut the advertisement out and carried it in my pocket knowing that I would be in Saint Louis at the World's Fair in charge of my Automobile Spring Exhibit, which was recently awarded a gold medal. I have now used the Cap for a little over three months and my photograph herewith will show you the results I have obtained. I mailed this photograph home to my wife in Boston, and her surprise at noting the growth of hair on my head will perhaps be appreciated by quoting from her letter:—'Your picture came in this morning, but how strange it seems. Are you wearing a wig or has the Cap really made your hair grow again?' Although I appreciate the honor of getting the gold medal on my own invention, yet I am frank to say that I have derived more satisfaction from having my hair restored than receiving the medal. My success with the Cap has been so pronounced that it has led to quite a number of sales among others who were watching my progress."

"I have been using your Vacuum Cap for eight weeks, and am pleased with the results. I hereby authorize the Jefferson Bank, of St. Louis, to pay you the amount deposited with them for the Cap sent me. Although there was no bald spot, the hair on the top of my head was quite thin and has been steadily growing thinner for several years. This condition was evidently due to failing nourishment of the scalp, as the scalp was otherwise perfectly healthy. I now have a new growth of hair averaging about one inch in length over the thin area, and if the improvement continues as I expect it to, you will doubtless receive other orders from my acquaintances here in Oakland."

"The new Cap that you sent me arrived safely, and while I have only had about ten days' use of it, yet my friends already have noticed an improvement in the appearance of my hair and I am glad you exchanged the Cap as I believe it is going to give excellent satisfaction. There is one question I would like to ask—is there any part of the pump which requires oiling? Your explanation of delay is entirely satisfactory. It may be that my haste in the matter was somewhat undignified, but you doubtless know that a man who is losing his hair and losing it fast, sometimes gets nervous over the fact."

"I purchased one of your Caps a few months ago and am pleased with results I am getting. I perspire freely and this seems to have the effect of rotting the rubber band. Can you send me a new one by mail? My hair had been falling out for over fifteen years, during which time I have tried practically every supposed remedy with absolutely no result (except injurious), but thanks to your Cap, the fuzz on my head has developed into hair."

The names and addresses of the writers of the above letters are omitted, and very properly so, but we have no objections to sending copies of the originals, together with the names and addresses, to any one interested, for private use. It will be understood by every reader that many of those who have used the Evans Vacuum Cap with the very best results are persons of prominence and position and standing, who could not, under any circumstances, permit their names and photographs to appear publicly in connection with any such personal announcement. They have no objection however, to our using them by correspondence.

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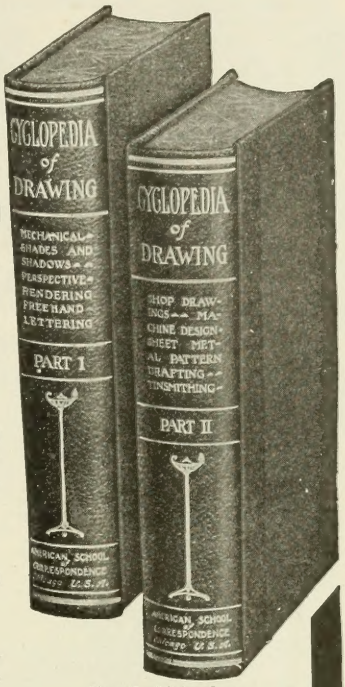
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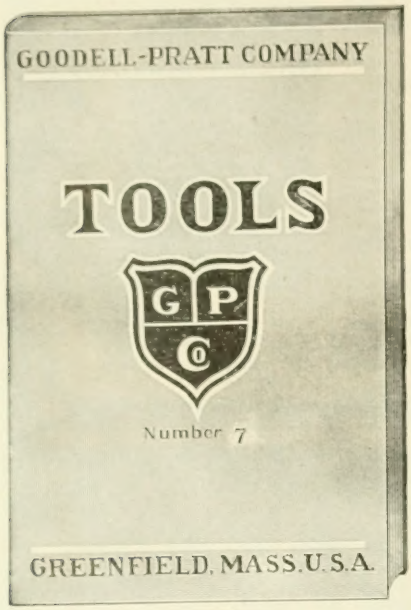

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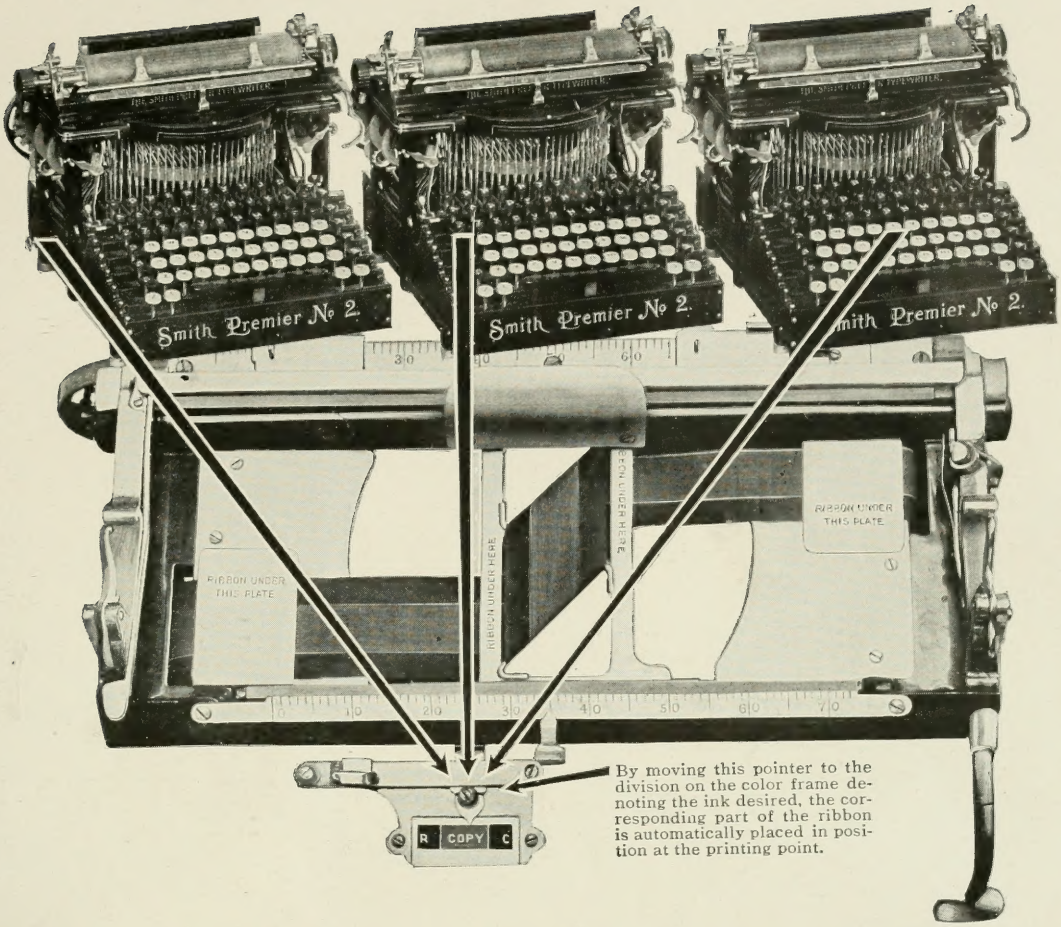

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